DRAFT

Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials

Centers for Disease Control and Prevention

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Foreword

Dear Colleague:

Lead poisoning among children must be eliminated. Lead, which is not an essential element, damages all bodily systems but has its most devastating effects on the developing brain. The damage that lead causes to developing brain cells has lifelong, albeit sometimes subtle, effects. All parents want their children to reach their full potential, but the damage caused by lead can rob children of their right to a productive and full life.

Improving public health demands commitment by health-care providers, government agencies, and advocacy groups to work together to accomplish seemingly overwhelming tasks for the good of all. Good people can honestly disagree about the best way to reach this goal. When it comes to lead poisoning among children, we all agree that preventing this devastating disease is our proper goal and that lead poisoning can be prevented. Where some disagreement still exists, however, is over how best to find those children who are exposed to lead and then to provide them with appropriate follow-up care and services. Is the best approach to screen all children, whether or not they are at high risk for exposure to lead, or should we target our efforts and our limited resources toward those children most in danger?

Children's blood lead levels in the United States have been declining dramatically, primarily as a result of public health efforts to reduce lead in gasoline and other sources. Results of CDC's Third National Health and Nutrition Examination Survey (NHANES III) show that the percentage of children with blood lead levels at or above 10 micrograms per deciliter fell sharply—from 89% at the time of NHANES II (1976-1980) to 8.9% at the time of Phase I of NHANES III (1988-1991). Further declines are expected in the results of Phase 2 of NHANES III (1991-1994). All Americans are benefitting from the continuing decline in blood lead levels, but NHANES data also indicate that lead poisoning is still a serious problem among urban, minority, and low-income children.

The policy recommendation of CDC's 1991 statement, Preventing Lead Poisoning in Young Children, was for virtually universal screening. Since 1991, our analysis of substantial scientific data and our considerable program experience have shown that we must direct our lead poisoning prevention efforts and limited resources toward those children in groups that are at the greatest risk. **The recommendations in this guidance are intended to increase the screening and follow-up care of children who most need these services and to ensure that prevention approaches are appropriate to local conditions.**

Our audience for these guidelines includes public health officials who will lead an inclusive process involving health care-providers, parents, and other concerned groups in bringing about better screening of children. The document is also intended for child health-care providers, public health agencies, and for our newest partner in the delivery of health-care, managed care organizations. We want to help them to focus on screening and providing follow-up care to children who most need those services and to reduce the unnecessary screening of children at low risk for lead exposure.

As parents, we worry about our children's health. As child health-care providers, we know the importance of delivering the best possible care to our patients and of listening to and addressing the concerns of their parents. Public health officials are critically aware of the impact that decisions made at the federal level have on state and local health departments and practitioners in the private sector, and those in federal agencies appreciate the complexity of the issues they face in guiding and supporting their agencies' programs.

We issue this guidance at a time when the health-care delivery system is undergoing rapid transformation and when these screening recommendations will be implemented in a variety of settings by a variety of providers. CDC hopes that this recommended approach to screening will help foster improved coop-

eration between public health agencies and child health-care providers to the benefit of all the children of this nation.

CDC is committed to continued support of state and local public health agencies in preventing childhood lead exposure and its consequences. In FY 1996 alone, CDC funded 30 states and 10 localities through our state- and community-based childhood lead poisoning prevention grants. These grants helped support screening, environmental and medical follow-up services, lead poisoning prevention education, and monitoring and surveillance activities. The process described in these guidelines will succeed or fail to the extent that it is embraced and "owned" by state and local health departments. As with politics, "all lead is local." The best decisions about screening are those that take into account local circumstances, conditions, and concerns. For this reason, CDC encourages its grantees to build partnerships with child health-care providers and other concerned groups at the local level.

CDC will soon begin issuing annual reports on childhood blood lead surveillance data. The first report contains data collected in 1994 by 10 states and reflects a remarkable achievement of these state health departments in improving their data-collection systems. The number of states that can collect, manage, and analyze large volumes of blood-lead testing data is growing rapidly, so subsequent expanded annual surveillance reports should provide us with information that will have a major impact on preventing childhood lead poisoning. CDC will also provide data, such as information about housing, through its Internet Home Page as a way of making data more immediately available to local leaders and citizens.

Meanwhile, other federal agencies, including the U.S. Environmental Protection Agency (EPA) and the Department of Housing and Urban Development (HUD), are also working toward reducing childhood lead exposure through regulation, guidance, and funding support. For example, EPA and HUD released the final regulations implementing the real-estate disclosure rule, which, among other stipulations, requires property owners or real estate agents to disclose known information about lead paint-related hazards when renting or selling most residences built before 1978.

As we continue to work together, I want to express my appreciation to the members of the CDC Advisory Committee, our consultants, and all who have contributed their talent in developing this guidance. I believe that the approach to childhood lead screening described in these pages will move the nation closer to its goal of eliminating childhood lead poisoning. Certainly, the children of this nation deserve no less.

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Preface

Lead poisoning is a major preventable environmental health problem for children in the United States. Since 1975, when the Centers for Disease Control and Prevention (CDC) issued its first comprehensive guidelines for preventing lead poisoning in children (Increased Lead Absorption and Lead Poisoning in Young Children), CDC has worked with public health agencies, child health-care providers, and various concerned groups to prevent lead poisoning in young children.[1] Other editions of guidelines were published in 1978, 1985, and 1991.[2] Each edition has incorporated new scientific and practical information on how best to reduce the adverse effects of lead on the health of young children. For example, on the basis of new information, several previous editions recommended decreasing the blood lead level that is considered to pose a health concern.

This current guidance is narrower in scope than the 1991 edition of Preventing Lead Poisoning in Young Children. It does not modify CDC's position on the adverse health effects caused by lead. Instead, it makes recommendations to improve the use of screening to prevent lead poisoning among young children. These recommendations are needed because data indicate that many children, especially those living in older housing, continue to be heavily exposed to lead, whereas the average exposure of children in the United States has substantially declined.[3]

To address this situation, **the recommendations in this guidance are intended to increase the screening and follow-up care of children who most need these services and to ensure that prevention approaches are appropriate to local conditions**. These recommendations take into account new scientific information and practical concerns about how best and most efficiently to prevent lead poisoning among children.

The audience for this guidance is state and local public health officials, who will make screening recommendations for their jurisdictions. It may also be used by pediatricians and other child health-care providers, public health agencies, and health care organizations, including managed care organizations.

This guidance primarily covers the screening and management of young children from birth to 72 months of age who are potentially exposed to lead. It also discusses 1) anticipatory guidance for pregnant women that is aimed at reducing their children's exposure to lead and 2) the screening and management of older children who are at risk for excessive lead exposure (e.g., children with excessive mouthing activity). This guidance does not address the screening of pregnant women or other adults for lead poisoning.

This guidance covers the following topics:

Chapter 1. Background on lead poisoning among children in the United States.

Chapter 2. Overview of activities to prevent lead poisoning among children.

Chapter 3. Guidance for public health officials making recommendations about blood lead screening.

Chapter 4. General guidance for child health-care providers on

[1] Center for Disease Control, 1975.

[2] Center for Disease Control, 1978; Centers for Disease Control, 1985; Centers for Disease Control, 1991.

[3] Brody DJ, Pirkle JL, Kramer RA, et al, 1994.

identifying children with elevated blood lead levels and providing appropriate follow-up services to these children.

Chapter 5. Evaluation of the impact of screening recommendations in a changing health care environment.

Chapter 6. Research priorities for lead poisoning prevention.

Several topics are not covered or are considered only briefly in this guidance. Some of these have been recently considered by other groups:

- The National Research Council has recently reviewed the adverse effects of lead exposure on health and the sources and pathways of lead exposure.[4]

- The American Academy of Pediatrics' Committee on Drugs has issued recommendations on chelation therapy for children with lead poisoning.[5]

- The U.S. Department of Housing and Urban Development has issued recommendations on managing lead hazards in the home environment.[6]

- The Lead-Based Paint Hazard Reduction and Financing Task Force has provided experience and recommendations on reducing lead hazards in housing.[7]

This guidance was prepared by CDC staff with advice from CDC's Advisory Committee on Childhood Lead Poisoning Prevention, a group of nonfederal experts in preventing lead poisoning among children. This guidance also reflects the comments of many other people involved in the scientific and program aspects of ensuring the health of children and preventing lead poisoning among children. CDC is committed to an ongoing process of updating guidance on preventing lead poisoning among children, and will determine the nature and extent of future guidance in consultation with its Advisory Committee.

CDC and others continue to work to improve the information on which recommendations for preventing lead poisoning among children are based. As the information improves, guidance for prevention will of necessity change to afford health care providers with the best ways to protect children in the United States from this troubling, persistent, and preventable environmental disease.

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[4] National Research Council, 1993.

[5] American Academy of Pediatrics Committee on Drugs, 1995.

[6] U.S. Department of Housing and Urban Development, 1995.

[7] Lead-Based Paint Hazard Reduction and Financing Task Force, 1995.

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Executive Summary

Background to Current CDC Recommendations

Childhood lead poisoning is a major, preventable environmental health problem. Blood lead levels (BLLs) as low as 10 µg/dL are associated with harmful effects on children's learning and behavior. Very high BLLs (≥ 70 µg/dL) cause devastating health consequences, including seizures, coma, and death. In 1990, 1.7 million U.S. children had blood lead levels (BLLs) ≥ 10 µg/dL. Since the virtual elimination of lead from gasoline, lead-based paint in homes has become the most important remaining source of lead exposure for U.S. children.

In 1991, the U.S. Department of Health and Human Services called for a concerted society-wide effort to eliminate childhood lead poisoning as a public health problem in 20 years, and issued its Strategic Plan for the Elimination of Childhood Lead Poisoning. The strategic plan describes an agenda for the first 5 years of a comprehensive effort which will lead to an agenda for the following 15 years. CDC and other federal agencies maintain their commitment to see this effort through.

Childhood blood lead screening is an important element of a comprehensive program to eliminate childhood lead poisoning. The goal of such screening is to identify children who need individual interventions to reduce their BLLs. The 1991 edition of *Preventing Lead Poisoning in Young Children* called for virtually universal screening of children 12-72 months of age. Nonetheless, a 1994 national survey showed that *only about one quarter of young children had been screened and only about one third of poor children, who are at higher risk of lead exposure than other children, had been screened*.

It is clear that many children who are at risk of lead exposure are not being screened. Thus, many children with BLLs high enough to require interventions to lower their BLLs are not being identified. It is the goal of this document to bring about such screening, by focusing efforts on the children who need to be screened.

Among the factors most often cited as contributing to low screening rates is that many parents and child health-care providers do not believe that lead exposure affects the community they live in. A universal screening recommendation from CDC has been ineffective in changing this belief.

It is important to note that some populations of children are heavily exposed to lead while others are not. A 1991 national estimate showed 37% of black children living in large central cities had elevated BLLs. Studies of other pediatric populations have shown quite low prevalence of elevated BLLs. For example a survey of 967 poor children in Alaska found none with a BLL ≥ 11 µg/dL. In addition, average BLLs for the population as a whole have declined dramatically since the 1970's. Whereas in 1978 the geometric mean BLL in children was 15 µg/dL, in 1990, the geometric mean was 3.6 µg/dL.

Many children, especially those living in older housing or who are poor, are still being harmed by the effects of lead exposure. The task for public health agencies, parents, and health-care providers is to identify those children who need lead screening and to ensure that they are screened and, if necessary, to provide appropriate interventions to lower their BLLs.

CDC Recommendations

This document contains CDC guidance for state and local public health officials on focusing blood lead screening on children who are most likely to need it. In general, these will be 1- and 2-year-old children who:

- Live in housing built prior to 1950.
- Are members of high-risk groups. These groups include: poor children, minority children, including black children and some groups of Hispanic and Asian-American children, and children whose parents are occupationally exposed to lead.

To bring about such screening, CDC recommends that public health officials lead an inclusive process to develop a state screening plan and make screening recommendations. These recommendations should be based on local assessment of the risk of childhood lead exposure. The planning and implementation process should engage health-care providers, parents, and other concerned members of the community so that they understand the risk of lead exposure and can identify those children who are likely to be at risk of such exposure.

Planning

Step 1. Identify sources of and examine information on the risk for lead exposure among children and assess the capacity of local health systems to oversee and provide lead screening. Data sources are discussed in detail in the CDC guideline.

Step 2. Determine the boundaries of recommendation areas. After analyzing the information from Step 1, public health officials should decide whether and how to sub-divide their jurisdictions into recommendation areas for making screening recommendations.

Step 3. Recommend screening for recommendation areas. Universal screening is the screening of all children at ages 1 and 2 in a recommendation area; targeted screening is the screening of some, but not all, children at ages 1 and 2. Universal or targeted screening should be recommended for each recommendation area, according to proportion of older housing or prevalence of elevated BLLs among children. CDC provides guidelines for making these recommendations.

Step 4. Design a targeted-screening recommendation. Where an assessment of local data indicates that targeted screening is appropriate, health officials should design a targeted-screening recommendation and provide screening criteria and a personal-risk questionnaire so that parents and child health-care providers can identify children who should be screened. (CDC recommends an inclusive process for developing the screening criteria and the personal-risk questionnaire.)

Screening criteria for recommendation areas with targeted screening. Screening criteria from the health department will make possible identification of children who should be screened in recommendation areas with targeted screening. These criteria are most likely to be: 1) residence in a high-risk zip code or neighborhood, and 2) membership in a high-risk group such as poor children or children of ethnic and racial minorities who are shown to be at risk by national or local data.

The use of the personal-risk questionnaire. Children who are at risk of lead exposure, but who are not identified on the basis of screening criteria, should be identified on the basis of a personal-risk questionnaire.

Development of the personal-risk questionnaire. A basic questionnaire is provided in the guidelines, along with suggestions about additional questions that might be relevant in certain places but not in others. Public health officials and their consultants should tailor the questionnaire to local conditions.

Implementation

Step 5: Communicate the screening recommendation. The screening recommendation should be clear, direct, and easy to use. It should make sense to the people who will carry it out.

Step 6: Monitor screening and evaluate its effectiveness. Public health officials should monitor the effects of the recommendations on screening and plan to evaluate and revise the recommendations as necessary.

CDC provides funding and technical advice to assist states and locales in all activities that are called for in the screening recommendations.

In the document, CDC also provides general guidelines about the roles and responsibilities of child health-care providers in preventing childhood lead poisoning, including anticipatory guidance, screening and follow-up testing, clinical management, chelation therapy, and family education about elevated BLLs.

Chapter 1. Childhood Lead Poisoning in the United States

Lead Poisoning

Childhood lead poisoning consists of the harmful effects of lead on children. A child is "lead poisoned" if he or she has developed one or more of the harmful effects of lead as a result of exposure to lead. Lead produces harmful effects on several body systems, including the nervous system, hematopoietic system, and the renal system. These effects can be acute and obvious (e.g., coma, seizure) or insidious (e.g., slowed mental development, anemia). The likelihood that lead will cause harmful effects and the nature of these effects are related to the extent and duration of exposure, which are usually ascertained by measuring the level of lead in blood: the greater the exposure and the longer the duration, the greater the likelihood that an individual child will suffer harmful effects and that the effects will be severe.

Blood Lead Levels of Concern

At low levels of lead, it may not be possible to determine whether an individual asymptomatic child is poisoned. Results of numerous studies have clearly shown, however, that children with levels of lead in their blood of 10 micrograms per deciliter (µg/dL) or greater are more likely to have learning and behavioral effects than children with levels of less than 10 µg/dL. For this reason, a child with a blood lead level (BLL) of 10 µg/dL or greater is considered to have an elevated BLL. (Some studies even suggest that there may be no threshold level of exposure below which the deleterious effects of lead do not occur.[8]) Given the BLL at which these effects can occur, national estimates developed from 1988-1991[3] show that exposure to lead remains a significant problem: approximately 1.7 million children in the United States had BLLs of ≥ 10 µg/dL.

Fortunately, childhood lead poisoning is preventable and treatable. Because the risk of poisoning increases as the level of lead increases, the need for and the extent of intervention and treatment should increase with increasing BLLs. Therefore, families of children with BLLs of 10µg/dL or greater should receive educational and other interventions as indicated to prevent further exposure to lead.

Childhood lead poisoning is a major preventable environmental problem.

- According to recent national estimates, 1.7 million U.S. children had elevated BLLs (≥ 10 µg/dL).
- Lead provides no known biological benefit to humans.
- Lead can produce adverse effects on several body systems, including the nervous system, the hemopoietic system, and the renal system.
- There may be no threshold for some of the adverse effects of lead on children.
- Lead can cause learning and behavioral problems in children who have BLLs at least as low as 10 µg/dL.
- The harm that lead causes to children increases as their BLLs increase.
- Very high BLLs (≥ 70 µg/dL) cause devastating health consequences, including seizures, coma, and death.

To determine whether exposure has been reduced or eliminated, children should be retested at appropriate intervals.[9] The child's parents should be advised that their child is at increased risk for lead poisoning. Further, the parents need to know how to prevent further exposure.

In addition to family education and retesting, children with venous BLLs of 20 µg/dL or greater or with venous BLLs of 15-19µg/dL that persist for at least 3 months should receive a

[8] Schwartz J, 1993; Schwartz J, 1994.

[9] See Chapter 4 for a detailed discussion of interventions and recommended intervals.

medical evaluation and treatment, if indicated, for lead poisoning.

Sources and Distribution of Lead in the Environment

Children can be exposed to lead in many ways. Sources of lead include lead-based paint, industrial sites and smelters that use or produce lead-containing materials, parental occupations or hobbies that use lead-containing materials, and lead-containing ceramicware and folk remedies. Children can also be exposed to lead-contaminated dust and soil and lead-contaminated water.[10]

Lead-based paint in homes is the most important remaining source of lead exposure for U.S. children. Substantial progress has been made in reducing other environmental sources of lead, especially from gasoline and food.[11] There are large reservoirs of lead in children's home environments. For example, 74% of all homes built before 1978 in the United States contain lead-based paint at a concentration of at least one mg/sq cm.[12]

The older the house, the more likely it is to contain lead-based paint and to have a higher concentration of lead in the paint.[12] Housing that was built before 1950 is unevenly distributed in the United States (see Table 1) and poses the greatest hazard to children.[7] However, even states with low overall rates of older housing still have areas that contain predominately older housing.[12]

The Distribution and Temporal Trend of Elevated BLLs In Children

As with sources of lead exposure, the prevalence of elevated BLLs among children varies widely in the U.S. (Table 2).

Table 1. Quantity and Percentage of U.S. Housing Built before 1950 by State

State	Housing Units		
	Total	Built before 1950	Built before 1950 (%)
Alabama	1,670,379	298,303	17.9
Alaska	232,608	16,248	7.0
Arizona	1,659,430	110,746	6.7
Arkansas	1,000,667	176,662	17.7
California	11,182,882	2,211,243	19.8
Colorado	1,477,349	270,562	18.3
Connecticut	1,320,850	462,808	35.0
Delaware	289,919	64,704	22.3
Dist. Columbia	278,489	155,194	55.7
Florida	6,100,262	472,481	7.7
Georgia	2,638,418	381,827	14.5
Hawaii	389,810	52,347	13.4
Idaho	413,327	100,738	24.4
Illinois	4,506,275	1,662,888	36.9
Indiana	2,246,046	756,843	33.7
Iowa	1,143,669	490,394	42.9
Kansas	1,044,112	345,564	33.1
Kentucky	1,506,845	364,678	24.2
Louisiana	1,716,241	333,965	19.5
Maine	587,045	242,858	41.1
Maryland	1,891,917	473,984	25.1
Massachusetts	2,472,711	1,157,737	46.8
Michigan	3,847,926	1,228,635	31.9
Minnesota	1,848,445	585,539	31.7
Mississippi	1,010,423	167,685	16.6
Missouri	2,199,129	629,868	28.6
Montana	361,155	108,805	30.1
Nebraska	660,621	249,631	37.8
Nevada	518,858	31,044	6.0
New Hampshire	503,904	162,201	32.2
New Jersey	3,075,310	1,082,081	35.2
New Mexico	632,058	97,750	15.5
New York	7,226,891	3,401,416	47.1
North Carolina	2,818,193	494,675	17.6
North Dakota	276,340	85,128	30.8
Ohio	4,371,945	1,561,695	35.7
Oklahoma	1,406,499	298,347	21.2
Oregon	1,193,567	316,648	26.5
Pennsylvania	4,938,140	2,213,386	44.8
Rhode Island	414,572	181,215	43.7
South Carolina	1,424,155	218,781	15.4
South Dakota	292,436	107,374	36.7
Tennessee	2,026,067	380,068	18.8
Texas	7,008,999	1,008,475	14.4
Utah	598,388	127,266	21.3
Vermont	271,214	109,780	40.5
Virginia	2,496,334	481,679	19.3
Washington	2,032,378	500,808	24.6
West Virginia	781,295	270,441	34.6
Wisconsin	2,055,774	757,204	36.8
Wyoming	203,411	48,254	23.7
TOTAL	**102,263,678**	**27,508,653**	**26.9**

Source: 1990 U.S. Census

[10] For more information on potential sources of lead in a child's environment, see Appendices A.5 and A.6.

[11] Pirkle JL, Brody DJ, Gunter EW, et al, 1994.

[12] U.S. Department of Housing and Urban Development, 1990.

Table 2. Percentage of Children Aged 1 to 5 Years with BLLs of 10 µg/dL or Greater by Race/Ethnicity, Income Level, and Urban Status in the United States From 1988 Through 1991

	All Children[16]	Non-Hispanic Whites	Non-Hispanic Blacks	Mexican-American
Income level[17]				
Low	16.3	9.8	28.4	8.8
Mid	5.4	4.8	8.9	5.6
High	4.0	4.3	5.8	0.0[18]
Urban status[19]				
Central city (≥ 1 million)	21.0	6.1[18]	36.7	17.0
Central city (< 1 million)	16.4	8.1	22.5	9.5
Noncentral city	5.8	5.2	11.2	7.0

Source: Brody DJ, Pirkle JL, Kramer RA, et al, 1994.

- Some children are heavily exposed to lead. The prevalence of elevated BLLs in black children living in large central cities was about 37% in 1991.[3] In contrast, other children are less exposed. The prevalence among white, suburban children who are not poor was about 4%.[3]
- Although urban children are the more heavily exposed to lead nationwide, some rural children are also heavily exposed to lead.[13]
- In some populations, the prevalence of BLLs high enough to warrant individual follow-up care is extremely low. For example, in 1994, only 0.6% of 967 children ages 6 years old and younger living in Alaska and receiving Medicaid benefits had BLLs of 10µg/dL or greater, and on repeat testing, none had a BLL above 11 µg/dL.[14]

Average BLLs in the United States have fallen dramatically since the 1970s. In 1978, the geometric mean BLL in children was 15 µg/dL; in 1990, the geometric mean was 3.6 µg/dL.[11]

The Unsatisfactory Delivery of Secondary Childhood Lead Poisoning Prevention Services

Many children who should be screened and have follow-up care and interventions to reduce their blood lead levels are not receiving needed services. A national telephone survey conducted by CDC in 1994 showed the following:[15]

- Only about 24% of parents reported that their young children had been screened.
- Among families living in housing built before 1960, only 29% of children were reported to have been screened.
- Although poor children are more likely than other children to be exposed to lead,[3] only about 30% of children in families making less than $20,000 per year had been screened.
- Only about 9% of houses had been tested for the presence of lead-based paint.

[13] Norman EH, Bordley C, Hertz-Picciotto I, Newton DA, 1994; Paulozzi LJ, Shapp J, Drawbaugh RE, Carney, JK, 1995.

[14] Robin LF, Beller M, Middaugh JP, 1994.

[15] Binder S, Matte TD, Kresnow M, Houston B, Sacks JJ, 1996.

[16] All includes race and ethnic groups in addition to those that are shown separately.

[17] Income level was defined by poverty-income ratio. People with missing information on income are not included in analysis of income level.

[18] Estimate may be unstable due to small sample size.

[19] Urban status was defined by population size and place of residence. The place of residence was designated as either within or not within the central city of a standard

Local studies of populations in which lead exposure is common[20] and of high-risk subpopulations of lower-risk populations,[21] have also shown that many high-risk children have not been screened.[22]

Responding To the Problem of Childhood Lead Poisoning

In 1991, the Department of Health and Human Services developed a *Strategic Plan for the Elimination of Childhood Lead Poisoning*.[23] describing an agenda for the first 5 years of a comprehensive effort that will lead to an agenda for the following 15 years. Since then, many federal initiatives have been developed and resources have been committed to eliminating this disease.

Although progress has been made in reducing children's exposures to lead, childhood lead poisoning remains a critical problem in many areas and in many populations because large reservoirs of lead remain in the environment. Additional actions must be taken to correct this problem, and the federal commitment to eradicating this disease must continue.

To be effective, prevention activities must take place at the local level and must be appropriate to local conditions, given the uneven distribution of children's exposures to lead hazards in the United States.

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metropolitan area. People with missing information on urban status are not included in the analysis of urban status.

[20] Casey R, Wiley C, Rutstein R, Pinto-Martin J, 1994; Fairbrother G, Friedman S, DuMont K, Lobach KS, 1996.

[21] Colorado Department of Public Health and Environment, 1996.

[22] It should be noted that screening rates for children vary among states and locales. In recent years, childhood lead poisoning prevention programs supported by federal and state funding have improved screening rates in many high-risk areas.

[23] Centers for Disease Control, 1991.

Chapter 2. Childhood Lead Poisoning Prevention Activities

Introduction

This chapter contains a brief discussion of the scope of childhood lead poisoning prevention activities and shows the place of screening in those activities. Historically, public-sector agencies (i.e., public health departments and housing or community-development agencies) have planned and carried out many of these activities in collaboration with child health-care providers, advocacy groups, community-based organizations, and other private-sector entities.

The extremely important role of the private sector in preventing childhood lead poisoning will be briefly discussed at the end of this chapter.

Health departments in counties and towns, in collaboration with affected neighborhoods and with assistance from state and federal agencies, usually decide which activities they will use to prevent childhood lead poisoning. Local planning and implementation are desirable because risk factors for childhood lead exposure differ from place to place.

Activities that are tailored to local conditions are likely to be more effective than a single national approach to preventing childhood lead poisoning. Activities may be placed in the following categories:

- Assessment-activities to determine the risk for lead exposure to children in a particular jurisdiction.
- Policy development-activities to bring about sound policies and programs on the basis of assessing the risk for lead exposure.
- Assurance-activities to ensure that appropriate actions to prevent childhood lead poisoning take place.[24]

Activities can be carried out by a combination of public- and private-sector groups, but ultimately, public-sector agencies must take responsibility for creating the conditions for executing these activities and monitoring their effectiveness.

Assessing Children's Exposure to Lead

Assessment activities include the following:

- Assessing local housing to determine the location and condition of older housing likely to contain deteriorating lead-based paint and the extent to which old housing is being repaired or renovated.
- Identifying operating or abandoned industrial sources of lead or waste disposal sites that cause direct exposure to children or indirect exposure as a result of their parents inadvertently bringing home lead particles or dust from the workplace.
- Evaluating lead levels in drinking water.
- Assessing demographic factors such as poverty.
- Evaluating the use of lead-containing folk remedies or pottery.
- Assessing local factors, such as hobbies (e.g., making stained-glass, bullets, or lead sinkers), that might cause childhood lead exposure.

Sometimes existing data provide the basis for assessment. For example, census data are a source of information about the two strongest predictors of childhood lead exposure-older housing and young children living in poverty. Data on local industrial sources of lead exposure and surveys of drinking water that might be contaminated by lead provide a view of other potential sources.

It may be necessary to collect additional data for assessment by performing surveys to determine whether there is household use of lead-containing remedies or ceramicware or by col-

[24] National Academy of Sciences Committee for the Study of the Future of Public Health, 1988.

lecting and analyzing local data on blood lead testing.[25]

Policy Development

Three major categories for activities should be considered in policy development: primary prevention, secondary prevention, and monitoring (surveillance).

Primary prevention activities

The goal of primary prevention is to reduce or eliminate lead hazards to which children could be exposed. In all places where there is risk for childhood lead exposure, primary prevention should be a priority.

Effective primary prevention should take place for all children, regardless of whether they receive blood lead screening, and should include at a minimum the following three types of activities:

- Systematic evaluation and control of residential lead-based paint hazards and other lead hazards in children's home environments through these mechanisms:

  1. Development of protective and enforceable housing and health codes for places with older housing.

  2. Environmental assessment of children's homes *before* the children have elevated BLLs, not after. The purpose of such an evaluation is to identify lead hazards in housing so that these hazards can be controlled.

- Education, including community-wide education, and anticipatory guidance by child health-care providers. Education should include information about the dangers of deteriorating lead-based paint and improper renovation of older housing.

- Identification and control of ongoing nonresidential sources of exposure, including point sources (such as smelters) and widely disseminated sources (such as drinking water).

Currently, national efforts in primary prevention of childhood lead poisoning are not optimal. Rather, most efforts to date have focused on secondary prevention. However, through the activities of many entities at the federal, state, and local levels, primary prevention efforts are proliferating and improving.

Primary prevention activities provide greatest benefit when they take place before childhood exposure occurs, that is, before children are 1) born, 2) achieve a level of mobility sufficient to increase lead exposure, or 3) move into a house containing lead hazards.

Therefore, primary prevention activities, especially community education and anticipatory guidance, often focus on households where risk for lead exposure is high and where expectant parents or infants who are not yet fully mobile (e.g., infants younger than 6 months old) reside.

Policies supporting primary prevention

Within public health agencies, there is a growing body of experience in developing policies for the primary prevention of lead exposure from deteriorating, older housing. Such policies are based on careful analysis of the various forces that must work together to prevent lead poisoning. These include the banking and real-estate industries, community groups, public agencies, and not-for-profit groups, to prevent lead poisoning.

A common aspect of policy development in primary prevention is the formation of advisory groups comprising representatives from a variety of concerned groups. The contribution of the health department, as convener of meetings, coalition-builder, and provider of essential data on the risk for lead exposure among children is critical.

Effective community education campaigns are also important aspects of policy development for primary prevention of lead exposure because they bring about public awareness of the problem of children's exposure to lead and conse-

[25] Chapter 3 and Appendices A.3 and A.4 contain a discussion of the use of blood lead testing data.

quently increase support for public policies to combat it.

Secondary prevention (screening and follow-up) activities

The goal of secondary prevention activities is to 1) identify children who need individual interventions to reduce their BLLs and 2) provide those interventions.

The method used to identify lead-exposed children is blood lead screening.[26] Screening is the routine testing of asymptomatic children for the presence of lead in their blood.[27]

A screening program includes blood lead screening and diagnostic evaluation and treatment of children whose BLLs are elevated.

Where universal screening is not appropriate, two methods are available to identify those children who should receive blood lead screening: environmental assessment and individual risk evaluation. Individual risk evaluation is usually carried out as part of routine child health care.

- Environmental assessment is the evaluation of lead hazards in children's physical environments as a way of deciding whether or not certain children should receive blood lead screening. The assessment may include measuring lead in 1) paint in housing, 2) dust, or 3) soil.

  This assessment is best performed on clusters of housing units of similar age and condition as a way of focusing blood lead testing activities. However, it is not widely used, probably because of its cost and the lack of program experience in using the assessment to make screening decisions.

- Individual risk evaluation is an evaluation that applies a set of criteria to a child or a child's family. These criteria, such as place of residence, membership in a high-risk group (e.g., poor children), or "yes" answers to a personal-risk questionnaire, may substitute for an environmental assessment to determine whether or not an individual child needs blood lead screening.

  On the basis of health department recommendations, clinicians should use the criteria in those places where universal blood lead screening is not recommended in order to determine which children to screen.

Policies supporting secondary prevention

Developing effective screening policies is a significant responsibility of public health officials. Public health agencies are instrumental in communicating these policies to child health-care providers and the public and in supporting the implementation of these policies.

Screening policy is the focus of this guidance document. Chapter 3 contains detailed recommendations for public health officials to use in developing screening recommendations. Below we show criteria to consider when developing screening policy.

Because of the rapid changes occurring in health care delivery, it is critical that public health departments develop protocols and guidance for child health-care providers on the appropriate follow-up care for children with elevated BLLs.

In many places, the traditional role of health departments in providing case management and follow-up services will be assumed by other agencies. To keep pace with these changing

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[26] Several criteria should be carefully considered when deciding whether to use screening as a method of finding cases of a particular health problem in a community or population (Wilson JMG, Jungner G, 1968):

- The condition sought should be an important health problem.
- There should be an accepted treatment for patients with recognized disease.
- Facilities for diagnosis and treatment should be available.
- There should be a recognizable latent or early symptomatic stage.
- There should be a suitable test or examination.
- The test should be acceptable to the population.
- The natural history of the condition, including development from latent to declared disease, should be adequately understood.
- There should be an agreed policy on whom to treat as patients.
- The cost of case-finding (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole.
- Case-finding should be a continuing process and not a "once and for all" project.

[27] See Chapter 3.

roles, it is the responsibility of health departments to develop policies ensuring the adequacy of follow-up care by these other agencies and to provide services such as training and monitoring.

Because the success of screening and follow-up care depends on the involvement and cooperation of child health-care providers, public health agencies should work with representatives of the provider community, managed care organizations, and child health agencies to develop policies encouraging appropriate screening and follow-up care.

Monitoring (surveillance)

Planning, evaluating, and revising childhood lead poisoning prevention activities require examining data from monitoring systems. Public health agencies should develop such systems to 1) collect blood lead test results (both elevated and nonelevated) and demographic information, 2) obtain the results of environmental investigations, 3) ascertain possible sources of lead exposure, and 4) obtain information on prescribed medical treatments.

These data should be used to show whether or not screening efforts are correctly focused, follow-up care is adequate, and exposure sources are identified and removed.

Public health and housing agencies also maintain information systems on lead-hazard reduction to collect information about 1) activities to reduce lead hazards and 2) the availability of lead-safe housing. These systems can be used to assess the response of a community to its childhood lead poisoning problem, to monitor the availability of lead-safe housing and the quality of lead-hazard reduction practices, and to target resources.

Policies that support monitoring

Monitoring activities are extremely important in providing the basis for developing and improving activities, as well as for providing local information to bolster policy development initiatives and encourage local action.

The existence of reliable data on elevated BLLs in children, exposure sources, and hazard-reduction activities depends on policies that support collecting and managing such data. For example, state health departments may require laboratories to report results of blood lead analyses as well as to report other types of data.

Selecting appropriate activities

Decisions about the appropriate mixture of primary prevention, secondary prevention, and monitoring activities should be based on the nature and extent of lead exposure to children in a particular jurisdiction. In many places, screening and follow-up care are an appropriate and necessary complement to primary prevention activities.

In other places, the screening of individual children may be less useful, and emphasis will be on primary prevention (e.g., on reducing exposures to lead in water systems or from industrial sources). Monitoring activities should be maintained so that any newly occurring lead-exposure risks can be detected and the effectiveness of efforts to reduce current exposures can be evaluated.

Assurance

Activities are necessary to ensure that jurisdictions assess childhood lead exposure and work to prevent it.

Ensuring collaboration, cooperation, and coordination

In the past, public health agencies have often served as providers of last resort, bringing screening and follow-up care to children who needed those services; in some cases, these agencies will continue in that role. Increasingly, however, they also will help to ensure the prevention of childhood lead poisoning by working with public and private-sector groups.

The activities of numerous concerned groups must be coordinated. These groups include those with interests in public health, child health care (including managed care organizations), public and private housing, environmental health, social services, community improvement, and real-estate, insurance, and banking.

Ensuring effectiveness of screening recommendations

When recommendations on appropriate screening activities are developed,[27] public health agencies need to communicate these recommendations, provide support to managed care organizations and child health-care providers in carrying them out, and monitor the results of the recommendations to ensure that they are being followed and that they make sense.

Routine examination of blood lead testing data and data collected on follow-up care is the surest way to determine whether screening recommendations are being followed and whether they need revision. For example, health care providers may determine, through their screening and follow-up care activities, that there are special exposure risks in the population which suggest the need for a broader screening effort than was previously thought necessary.

In contrast, there may be excellent screening in an area, but it may identify few children with elevated BLLs. Such a finding may suggest the need to target screening more effectively in that particular place. In either case, there is assurance that appropriate activities are sustained or altered to suit demonstrated need.

Ensuring appropriate case management

A specific and important instance in which cooperation is the backbone of the assurance function is found in the "multidisciplinary team" that provides follow-up care for children with elevated BLLs. These teams may include a child health-care provider, a case-management coordinator, a community-health nurse or health advisor, an environmental specialist, a social services liaison, and a housing specialist.

Public health agencies usually plan and convene meetings and coordinate appropriate teams, but the responsibility for monitoring and ensuring good outcomes for children in case management is shared among team members.

Activities in the private sector

The private sector plays a critical role in preventing lead poisoning among children, and the contribution of child health-care providers and managed care organizations in providing patient education, screening, and follow-up care is central to these efforts. In primary prevention, the real estate, banking, and insurance industries play a crucial role in reducing childhood lead exposure from lead-based paint hazards in housing.

Title X of the Residential Lead-Based Paint Hazard Reduction Act of 1992[28] promotes primary prevention in the private sector by requiring property owners to disclose known information about lead paint-related hazards when selling or renting most residences built before 1978.

Property owners or real estate agents must provide an educational pamphlet and give prospective buyers up to 10 days to inspect for lead hazards at their own expense. It is widely expected that these provisions will increase primary prevention activities in the private sector by educating parents and future parents about lead hazards and by bringing about more lead-hazard inspection and remediation before children are exposed.

Recommendations from a task force[7] established by the law include standards for property owners to use in controlling lead hazards in rental housing built before 1978 and suggest ways that the banking and insurance industries can pressure property owners to comply with these standards.

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[28] Residential Lead-Based Hazard Reduction Act of 1992, 1992.

Chapter 3. Guidelines for Health Officials Making Blood Lead Screening Recommendations

Introduction

This chapter presents a process for public health officials to use so that appropriate childhood blood lead screening[29] can be done. Public health officials should make screening recommendations for their jurisdictions, bearing in mind that the major goal of lead screening is to identify children who need individual interventions in order to reduce their BLLs.

NHANES III[3] and other studies demonstrate that childhood lead exposure is associated with—

- Residence in older housing.
- Membership in certain high-risk groups. These groups include poor children, black children, some groups of Hispanic and Asian-American children, and children of occupationally exposed adults.

In general, children who live in older housing should receive blood lead screening.[30] Children who are members of high-risk groups should be screened unless adequate blood lead prevalence data[31] indicate that they are not at risk.[32]

Statewide Plans for Screening Children

To bring about effective screening, state health officials should devise a statewide plan for screening of children. These officials should make decisions about whether to make a single statewide screening recommendation or to subdivide the state into smaller areas for the purpose of making screening recommendations.

Working in collaboration with local health officials, child health-care providers, and other concerned groups, state health officials should develop screening recommendations on the basis of local information about elevated BLLs in children, older housing, and demographic characteristics of children. State health officials should ensure that the recommendations are carried out and should monitor the effectiveness of the recommendations.

State or local health officials (or their designees), rather than other agents, should make decisions about screening strategies for their jurisdictions.[33] To ensure that screening recom-

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[29] In this chapter, the terms *screening, prevalence, targeted screening, personal-risk questionnaire, jurisdiction, and recommendation area* are used in precise ways and are defined in the glossary at the end of this document.

[30] See footnote 36 for discussion of older housing.

[31] See figure 1 in this chapter for a discussion of the evaluation of the quality of blood lead screening data.

[32] Children who are members of high-risk groups but who are not exposed to environmental lead do not have elevated BLLs.

[33] Individual child health-care providers or provider groups may want to make their own screening policies for the children in their practices or their enrolled populations. Instead, CDC recommends that public health officials make such screening policies because of the following concerns:

Unrepresentative data. Not all children have ready access to or routinely use health-care services for which they are eligible. According to some studies, children without routine access to health care may have higher BLLs than children who have ready access to and routinely use health care services (see Fairbrother G, Friedman S, DuMont K, Lobach KS, 1996; Daniel K, Sedlis MH, Polk L, Dowuona-Hammond S, McCants B, Matte T, 1990). Examination of BLL data obtained for only those children who routinely visit clinics or health-care providers' offices could lead providers to the conclusion that lead exposure is not a problem in children eligible for their services when, in fact, it may be a problem for some children.

Incomplete data. Screening recommendations should be based on analysis of data from several sources. Some population-based information on risk factors for lead exposure and on BLLs among children may not be readily available to individual providers or provider groups.

Inconsistent policies. In order to ensure that adequate screening takes place in entire jurisdictions, CDC recommends that public health officials lead a jurisdiction-wide policy-making process that includes child health-care providers and others with an interest in or knowledge of childhood lead poisoning. Leaving policy making to individual providers could result in an inconsistent and

mendations are well thought out and that all viewpoints have been considered, public health officials should provide leadership throughout an inclusive process and should solicit the participation of key groups, especially child health-care providers and other concerned groups.

Although it is possible for health officials to make screening recommendations that are based solely on national data, CDC advocates that such recommendations be based on local information. Screening recommendations that are founded on an assessment of local data should be more effective in identifying lead-exposed children and will be more readily accepted by the child health-care providers who must carry out the recommendations.

It should be noted that, in 1997, many state and local public health agencies were already basing their screening efforts on local information about BLLs, housing, and demographics. For examples of their work, see footnotes 49, 51, 69, and 72. Many more agencies are developing the capacity to use local data to make decisions about effective screening.

Nonetheless, pending the further development of recommendations that are based on conditions in their jurisdictions, health officials may choose to use as a starting point a screening recommendation that is based on national data:[34]

> *Within the state or locale for which this screening recommendation is made, child health-care providers should do the following:*
>
> - *Screen all children at ages 1 and 2 who live in high-risk zip codes (i.e., zip codes where ³ 27% of housing was built before 1950).*
> - *Screen all children who receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants, and Children (WIC).*
> - *Administer a personal-risk questionnaire, such as that included in this chapter, to parents of children who live in low-risk zip codes (i.e., zip codes where <27% of housing was built before 1950), and screen children if parents answer "yes" or "unknown" to one or more questions.*

For states in which health officials do not develop a state screening plan or issue screening recommendations, that is, when no formal guidance is provided, universal screening for virtually all young children, as called for in the 1991 edition of *Preventing Lead Poisoning in Young Children*,[35] should be carried out.

Through technical assistance and the CDC grant program, CDC will encourage the development of statewide plans for screening children.

Planning Process

The planning process includes identifying sources of and examining information on the risks of lead exposure; analyzing that information in order to determine whether lead exposure is widely distributed or clustered in certain places; assessing the capacity of public health infrastructure to oversee screening; and making screening recommendations that will be effective, given gaps in data or insufficiencies in public health systems.

CDC recommends using the following four steps in the planning process. It may be possible to combine individual steps or to apply them at different jurisdictional levels, depending on state and local circumstances. The first two steps should be accomplished at the state level. In many places, the third and fourth steps will be better accomplished at the local level. More than one effective strategy is possible. The goal is to identify and screen all children who are likely to benefit from blood lead screening.

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bewildering array of screening policies and practices within a jurisdiction.

[34] The rationale for the provisions in this sample recommendation is explained in detail later in this chapter.

[35] Centers for Disease Control, 1991.

Step 1: Identify sources of and examine information on the risk for lead exposure and assess the capacity of local health systems to oversee and provide lead screening.

Identify sources of and examine information on risk for lead exposure.

Recommended sources of information are:

- Data on children's BLLs (if enough reliable, representative data are available).
- Data on the distribution of older housing.
- Data on the demographic characteristics of children.
- Data on other local sources of lead exposure.

Data on BLLs. As a basis for making screening decisions, information about the prevalence of elevated BLLs in 1- and 2-year-old children is preferable to information about housing. However, it is necessary to evaluate existing data on BLLs and to decide whether they provide an adequate basis for decision making.

Information from small numbers of children or data limited to certain geographic areas or population groups may be misleading. Figure 1 provides an algorithm for interpreting and evaluating the quality of BLL data.

Data on housing. Housing built before 1950 poses the greatest risk for lead exposure that will result in elevated BLLs in children.[36] Data on the proportion of housing built before 1950 can be used with BLL prevalence data to estimate the lead-exposure risk in an area or, if adequate prevalence data are unavailable, housing data can be used alone.[37] Such data are readily available from the U. S. Census for states, counties, zip codes, census tracts, and census block groups.

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[36] **Housing built before 1950 poses the greatest risk for lead exposure** among children because it is much more likely to contain lead-based paint than newer housing. For example, housing built before 1950 contains 92% of all lead carbonate used in paint. Lead carbonate was the most important lead compound used in house paint (see Lead-Based Paint Hazard Reduction and Financing Task Force, 1995).

Paint that was manufactured after 1950 typically contains much lower concentrations of lead than paint manufactured before that year (see U.S. Department of Housing and Urban Development, 1990), and the manufacture and use of paint with ≥0.06% lead by weight was banned for residences in 1978.

Twenty-seven percent of housing in the United States was built before 1950. Percentages of pre-1950 housing in individual states and the District of Columbia range from 6% to 56%. Percentages of such housing in individual counties range from 2% to 76% (see Bureau of the Census, 1992).

Two recent studies reinforce the important relationship between housing age and BLLs. Although the two studies use cut-off dates for age of housing other than 1950, the date used in these guidelines, the data suggest that 1950 is a reasonable cut-off date:

1. In 1994 in Youngstown, Ohio, investigators obtained BLLs from 1- to 3-year-old children who had lived their entire lives in one house and obtained data on the age of their housing from the county auditor (see Gemmel D, 1995). The relationship of housing age and average BLL was as follows:

Year house built	Arithmetic mean BLL
Before 1940	6.82
1940 - 1959	3.38
1960 - 1979	3.01
1980 onward	2.48

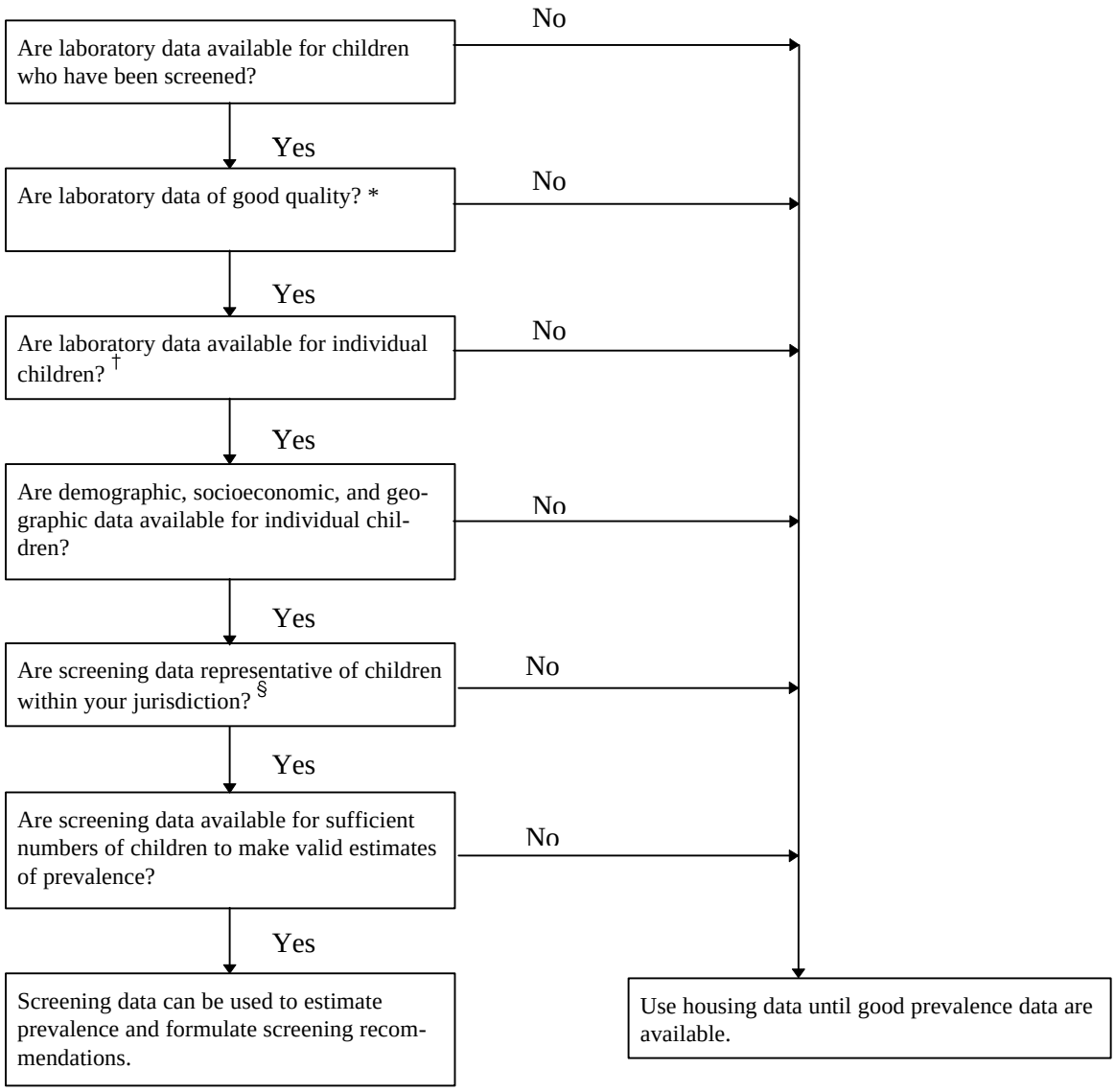
2. Data from Phase 1 of the NHANES III show the following relationship between self-reported age of housing and the percentage of children aged 1-5 years living in this housing who had elevated BLLs:

Year House Built	% of children who had BLLs ≥ 10 μg/dL
Before 1946	17%
1946 - 1973	8%
Post-1973	6%
Mobile home	2%
Unknown/refused	13%

Note: To the extent that housing age in this study is misclassified-because children do not live their entire lives in one house or because self-reports of housing age are in error-this study underestimates the strength of the relationship of living in older housing and having an elevated BLL.

[37] BLL data and housing data provide different information. Housing data give information about the main source of current exposure, as well as a source of potential future exposure, whereas BLL data give information only about current exposure.

Figure 1. Algorithm for Evaluating Blood Lead Screening Data



* Are the laboratories reporting data participating successfully in an approved proficiency testing program?

† Can the results of laboratory tests be linked to individual children?

§ Is the demographic, socioeconomic, and geographic distribution of children screened similar to the distribution of all children in the recommendation area? Data on the demographic, socioeconomic, and geographic distribution of children may be available from the U.S. Census or from state or local agencies.

Screening data that are not representative of the entire population of children within a jurisdiction may still be useful for decision-making if these data are representative of those who are at the highest or the lowest risk for exposure to lead. For example, screening data that are representative of the highest risk children (e.g., poor children, children who live in older housing in poor condition) yet show a low prevalence of elevated BLLs suggest that it may not necessary to screen all children. Conversely, screening data that are representative of the lowest-risk children (e.g., non-poor children, children in newer housing) yet show a high prevalence of elevated BLLs suggest that it may be necessary to screen all children. Screening data that are not representative of either a particular risk group or the population as a whole are not useful in decision making.

Data on demographic characteristics of children. Children with certain demographic characteristics are at higher risk for elevated BLLs than other children. Poor children are at higher risk than other children; children living in central cities are at higher risk than other children; black children are at much higher risk than other children;[3] and in some places, other minorities may be at higher risk than other children.[38]

Demographic data from the 1990 U.S. Census can be used to identify places with high proportions of children who may be at high risk for lead exposure for reasons other than residence in older housing. However, demographic data do not predict risk in every community. Children with the demographic characteristics listed above, but who are not exposed to environmental lead, do not have elevated BLLs.

Public health officials should use demographic data to predict the location of high-risk children and, where possible, they should examine existing or to collect additional BLL data to see whether these predictions are accurate.

Data on the presence of other sources of lead. Other sources of lead exposure, such as pottery, folk remedies, operating or abandoned industrial sources, waste-disposal sites, and drinking water may be important in some places. Data on these sources should also be examined when assessing risk.

Assess the capacity of local public health systems to oversee and provide lead screening.

State health officials should examine local information about the following:

- Organization and capacity of local health departments to oversee lead screening in their jurisdictions.
- Current screening activity.
- Existing capacity to collect and analyze data to monitor screening activity.
- Child health-care delivery systems and patterns.
- Enrollment of local Medicaid populations in managed-care plans.
- Public health department support for screening activities among private providers, including managed care organizations. (Includes outreach to child health-care providers to encourage screening, and assistance in providing follow-up care for children with elevated BLLs.)
- Public health department capacity to provide screening for children who lack access to other health-care providers.

On the basis of such information, state health officials should determine the capacity and readiness of local public health systems to oversee and provide screening. Such a determination will be important in the decision by state health officials about whether to promulgate a single, statewide recommendation or to have local health officials (e.g., major cities, counties) issue separate recommendations for their jurisdictions.

Step 2: Determine the boundaries of recommendation areas

A *recommendation area* is a geographic area for which a screening recommendation may be reasonably made. The boundaries of such areas should be drawn after analysis of the information outlined in Step 1, that is, information on the risk for lead exposure and the capacity of local public health systems to oversee and provide screening.

Risk for lead exposure. In a state or even in a local area, the distribution of lead hazards (e.g., older housing) and of the numbers and proportions of children at increased risk of lead exposure may or may not be uniform. Where such risk is reasonably uniform, determining the boundaries of recommendation areas will usually be fairly easy. In contrast, in those places where the distribution is not uniform, determining boundaries will usually be more complex.

Capacity to oversee and provide screening. States may have some local public health systems that can oversee and provide effective screening and others that cannot. Also, the boundaries of local health jurisdictions may or

[38] Rothenberg SJ, Williams Jr FA, Delrahim S, et al, 1996.

may not be the same as the boundaries of areas within which lead-exposure hazards and risks are uniformly distributed. The need to consider both risk and health-system capacity complicates the process of subdividing a state or local area into recommendation areas.

In practice, there will be two types of recommendation areas: those in which *universal* screening will be required and those in which *targeted* screening will be required.

A recommendation area where *universal* screening would be appropriate is one in which the prevalence of elevated BLLs or the proportion of older housing indicates a widespread level of risk such that screening all children is the best policy.[39] A state could comprise a single such recommendation area or could contain several such recommendation areas, along with some targeted-screening recommendation areas.

A recommendation area where *targeted* screening would be appropriate is one in which the prevalence of elevated BLLs or the proportion of older housing does not indicate widespread risk, and screening of all children is not the best policy.[40] Targeted-screening recommendations will need to include health-department criteria by which child health-care providers and parents can identify children who need screening.[41] For example, where a large city is a designated recommendation area with targeted screening, there may be certain zip codes in which there are high percentages of older housing and in which all children should be screened. In this case, the targeted-screening recommendation should specify residence in certain zip codes as a criterion for selecting children for screening that is easily recognized by families and child health-care providers.

Step 3: Recommend Screening for Each Recommendation Area

Based on information gathered in steps 1 and 2, recommend either *universal* or *targeted* screening for each recommendation area.

[39] See step 3 for rationales for policy-making.

[40] See step 3.

[41] See step 4 for guidelines on designing a targeted-screening recommendation.

Universal screening

Universal screening is straightforward: screen all children at ages 1 and 2 and children from 36-72 months of age who have not been screened previously.

Using the guidelines in Table 3, public health officials should recommend universal screening for recommendation areas in which one of the following applies:

- Twelve percent or more of 1- and 2-year-old children have elevated BLLs.
- Prevalence of elevated BLLs is unknown and 27% or more of the housing was built before 1950.

Targeted screening

The targeted-screening recommendation is more complex because it must provide clear direction to child health-care providers and families about health department criteria for identifying children in need of screening.

Using the guidelines in Table 3, public health officials should recommend targeted screening for recommendation areas in which one of the following applies:

- Less than 12% of 1- and 2-year-old children have elevated BLLs.
- Prevalence of elevated BLLs is unknown and less than 27% of the housing was built before 1950.

> A universal screening recommendation for a recommendation area would be: Screen all children at ages one and two.
>
> A targeted screening reommendation for a recommendation area would be: Screen all children at ages one and two who meet at least one of the health department criteria. (See step 4).

Step 4: Design a Targeted Screening Recommendation

The targeted screening recommendation should provide criteria by which children who need

Table 3. Recommended Screening that is Based on BLL and Housing Data

Percentage of 1- and 2-year-old children with elevated BLLs[42, 43]	Percentage of housing stock built before 1950[44]	Recommended screening[45]
≥ 12%	—	Screen all children
< 12%	≥ 27%	Screen all children or selected children[46]
3 - 12%	< 27%	Screen selected children
< 3%	< 27%	Screen selected children[47]
Unknown (or inadequate data)	≥ 27%	Screen all children
Unknown (or inadequate data)	< 27%	Screen selected children

[42] See Appendix A.3 for a discussion of the relationship between prevalence of BLLs at ≥10 µg/dL and prevalences above other cut-off levels.

[43] "Elevated BLLs" means BLLs ≥ 10µg/dL and refers to results of initial screening tests, regardless of type of specimen collected (venous or capillary).

[44] Data from the 1990 U.S. Census indicate that 27% of U.S. housing was built before 1950. Thus, places with a percentage of housing built before 1950 that is greater than 27 have a potentially higher-than-average risk for childhood lead exposure.

[45] In recommendation areas where 12% or more of 1- and 2-year-old children have BLLs ≥ 10 µg/dL, CDC recommends universal screening for two reasons:

1. In recommendation areas where the prevalence of children with BLLs of ≥ 10µg/dL is less than 12%, the vast majority of children (approximately ≥ 99%; see Appendix A.3) have BLLs of less than 20µg/dL, so universal screening would detect very few children who require clinical management and an environmental investigation.
2. A cost-benefit analysis of universal screening for elevated BLLs (Appendix A.2) suggests that the benefits of screening exceed the costs at prevalences of elevated BLLs of approximately 11% to 14%, depending on type of screening sample (capillary or venous). Twelve percent is chosen as the cut-off point for the sake of clarity, and also represents the midpoint of the range 11% to 14% (12.5%, conservatively rounded to 12%).

In recommendation areas where adequate BLL data are not available, CDC recommends basing the choice of universal or targeted screening on data about the age of housing. Where 27% or more of housing was built prior to 1950, CDC recommends universal screening. Data from the 1990 U.S. Census show that nationally, 27% of housing was built before 1950 (see Bureau of the Census, 1992). Thus, children living in areas where 27% or more of housing was built prior to 1950 may be at greater than average risk for lead exposure.

[46] The situation in which housing is relatively old but the prevalence of elevated BLLs among residents is low does occur and should provoke particularly careful consideration of an appropriate screening recommendation. The following issues should be considered:

- Pay particular attention to the quality of blood lead testing data. If the data are thought to be of poor quality, universal screening should be recommended.
- Note that a low prevalence of elevated BLLs among residents of older housing can occur if the housing is well maintained. If targeted screening is used in such a setting, the condition of the housing should be carefully monitored, and any deterioration should provoke consideration of universal screening. Universal screening may sometimes be more feasible than targeted screening in this setting.

[47] See page 40 for discussion of screening in extremely low prevalence areas.

screening are to be identified. Most often, these criteria will be used:

- Residence in a specific geographic area, for example, a zip code.
- Membership in a high-risk group.
- Answers to a personal-risk questionnaire.

Criterion 1: Residence in a geographic area. As public health officials develop a targeted screening recommendation for a recommendation area, they should closely examine data on BLLs, housing, and demographic characteristics of children (e.g., those living in poverty) to see whether there are smaller areas within the recommendation area, such as zip codes, neighborhoods, or census tracts, within which all children should be screened.

Generally, the smaller the area to which the guidelines in Table 3 are applied, the more precise the targeting of screening will be. For example, the census tract is generally smaller in area than the zip code; analysis of data for a recommendation area by census tract may reveal clusters or "pockets" of lead exposure that would be obscured in an analysis of the same data by zip code. Table 4 and Figure 2 show an example of how the presence of older housing can be seen to vary when county data (Table 4a and Figure 2a) are analyzed at a greater level of geographic detail (i.e., at level of zip code, Table 4b and Figure 2b, and census tract, Table 4c and Figure 2c). Such analysis is greatly facilitated by the use of mapping software and computerized data, such as data from the U.S. Census.[48,49]

It must be remembered, however, that the purpose of a *targeted* screening recommendation is to enable families and child health-care providers to readily identify children who should be screened. Relatively small geographic units, such as census tract or census block, may be desirable for analyzing data and for locating "pockets" of lead exposure. But the boundaries of these units are not recognized by most people and are unlikely to be useful to parents or child health-care providers as a way of identifying children who need screening. In most places, it will probably be more useful to use residence in readily identifiable geographic areas, such as a zip code[50] or an established "neighborhood" [51] to identify children for screening.

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[48] Recent advances in mapping software, coupled with the ready availability of electronic data files from the U.S. Census, make it easier to portray and distinguish geographic areas within recommendation areas where there are high proportions of older housing or where children who may belong to high-risk groups live. CDC works with state and local public health agencies to use these data systems in developing screening recommendations.

[49] To determine the effects of a targeted-screening recommendation, an analysis was performed of childhood blood lead surveillance data collected in 1995 in Rhode Island, a state with unusually complete screening data (P. Simon, M.D., S. Feeley, M.P.H., Rhode Island Department of Health, personal communication, 1996).

If the entire state were a single recommendation area with targeted screening,

- Following the criterion "screen all children in zip codes where at least 12% of children have elevated BLLs" would result in identifying 85% of children with BLLs of at least 10 µg/dL.
- Following the criterion "screen all children in zip codes where at least 27% of housing was built before 1950" would result in identifying 92% of children with BLLs of at least 10 µg/dL.
- Following the criterion "screen all children in census tracts where at least 12% of children have elevated BLLs" would result in identifying 88% of children with BLLs of at least 10 µg/dL.
- Following the criterion "screen all children in census tracts where at least 27% of housing was built before 1950" would result in identifying 93% of children with BLLs of at least 10 µg/dL.

Note: The analysis included the extremely conservative assumption that *no* screening would occur in zip codes that fell below the cut-off point, although this approach is in no way condoned in these guidelines.

[50] **Using residence in a zip code to identify children for screening.**

Every state contains zip codes in which the proportion of housing built before 1950 is ≥ 27% (see Bureau of the Census, 1992). There may also be zip codes in which all children should be screened due to the presence of a high proportion of children in high-risk groups, such as children living in poverty.

There are several advantages to using residence in a zip code to identify children for screening in a recommendation area where targeted screening is recommended:

- Zip codes are relatively small compared with the area of a state or county and many have relatively uniform risks for lead exposure.
- Families and child health-care providers can easily determine the zip code in which a child resides.
- Data on factors associated with lead exposure (e.g., older housing, children living in poverty) are available in U.S. Census data files for every zip code.

Criterion 2: Membership in certain high-risk groups. Recommendation areas with targeted screening will often contain high-risk groups of children, all of whom should be screened.

NHANES III data[3] and results of other studies[38] demonstrate that poor children, children who are members of racial/ethnic minority groups, including black children and some groups of Hispanic and Asian-American children, and children of occupationally exposed adults are at higher risk for lead exposure than other children.

Membership in one or more of these groups does not predict risk in every community. Children with these demographic characteristics who are not exposed to environmental lead do not have elevated BLLs. However, unless these children are known to be at low risk in a particular recommendation area, they should be screened.

Screening poor children. Special consideration must be given to screening poor children because they are at higher-than-average risk for lead exposure and they may not receive adequate well-child care, for a variety of reasons.

All children in federally-funded well-child programs should be screened unless high quality local data show that the prevalence of elevated BLLs among poor children in a recommendation area is less than 12%.[52] In this case, other methods for identifying lead-exposed children should be carefully considered.

Screening of poor children could be enhanced in many ways, including the following:

- By adding questions that are proxies for poverty to a personal-risk questionnaire.
- By recommending increased screening in public or community clinics that provide care to poor populations than are recommended in health-care settings that serve more advantaged children.

- Public health officials can easily monitor the amount of screening done in specified zip codes by examining laboratory reports on the results of blood lead testing. (Zip code of residence is a key piece of information that should always be included in such laboratory reports.)

However, there may be disadvantages to using zip codes:

- Zip-code boundaries may not approximate the boundaries of areas where there are high proportions of older housing or children with elevated BLLs. (See footnote 51 for a discussion of such a situation.)
- Zip codes may change over time, thereby rendering census estimates at the zip code level less accurate as a basis for decision making.
- Zip codes may contain a large number of people and housing units. In such zip codes, the proportion of older housing units or children with elevated BLLs may be small, but the actual number may be large. In such recommendation areas, health officials should find a feasible means, other than zip code, by which child health-care providers and families may identify children in need of screening. Alternatively, the health department may need to make outreach efforts to screen those children living in older housing or those living in poverty..

[51] **Example of the use of residence in a "neighborhood" to identify children for screening.**
In some places, effective screening recommendations can be based on residence in a recognized or established "neighborhood" where the risk of lead exposure is high. For example: public health officials in Salt Lake City surveyed 5,168 children attending WIC clinics. Officials found that only 1.8 % of children who were screened had BLLs of ≥ 10 µg/dL, but seven children had BLLs of at least 20µg/dL. The children with BLLs greater than 20µg/dL were clustered in a relatively small central-city neighborhood, where a high proportion of houses was built before 1950.

Public health officials recommended screening for all 1-and 2-year-old children in the high-risk area which could be identified by its borders, consisting of well-known streets and natural boundaries. They distributed a map of the area to child health-care providers, who show the map to families at the time of a clinic visit and ask whether they live within the high-risk area.

To further communicate its recommendation, the health department conducted a mass mailing to all 72,000 households within the high-risk area, advising families to have their children screened (Centers for Disease Control and Prevention, In press.).

[52] Some state Medicaid agencies may make Medicaid status "invisible" to health-care providers in order to reduce the possibility that children could be discriminated against on the basis of their insurance status. This action may make it impractical in some areas to target screening on the basis of a child's enrollment in Medicaid. In such cases, it will be important to identify other reasonable proxies for poverty, such as residence in a zip code with a high percentage of poor families.

Table 4. Number and percent of housing units that were built before 1950 in South Carolina-An example of geographic analysis at three different levels: county, zip code, and census tract.

Table 4a. South Carolina by county.

County	%	Number	County	%	Number
Union	**29.8**	**3,650**	Greenville	17.6	23,191
Newberry	**28.9**	**4,179**	Charleston	17.1	21,117
Chester	26.2	3,225	Williamsburg	16.8	2,235
Abbeville	25.1	2,469	Pickens	16.5	5,917
Marlboro	24.0	2,628	Colleton	15.9	2,371
Fairfield	23.5	2,055	York	15.8	7,949
Greenwood	23.0	5,682	Barnwell	15.6	1,229
Mccormick	21.9	732	Richland	15.2	16,623
Edgefield	21.6	1,571	Kershaw	15.2	2,658
Calhoun	21.3	1,112	Jasper	14.6	886
Dillon	20.7	2,187	Florence	14.5	6,275
Spartanburg	20.4	18,344	Oconee	14.3	3,706
Chesterfield	19.8	2,991	Orangeburg	13.9	4,491
Laurens	19.5	4,518	Sumter	13.4	4,676
Lee	19.2	1,257	Aiken	13.0	6,396
Cherokee	19.2	3,386	Georgetown	12.5	2,643
Saluda	19.1	1,296	Clarendon	11.6	1,399
Lancaster	18.9	3,962	Dorchester	8.6	2,638
Hampton	18.8	1,327	Lexington	8.3	5,610
Bamberg	18.4	1,181	Beaufort	6.2	2,845
Darlington	18.2	4,293	Berkeley	5.8	2,649
Anderson	18.2	11,034	Horry	5.7	5,147
Allendale	17.9	759			
Marion	17.9	2,292	**South Carolina**	**15.4**	**218,781**

Table 4b. Greenville County South Carolina, by zip code

Zip Code	%	Number
29601	**49.5**	**2,888**
29605	**30.9**	**4,112**
29322	**28.1**	**79**
29609	**27.8**	**3,700**
29635	25.1	99
29611	24.1	4,229
29661	23.0	526
29356	22.8	241
29651	17.1	818
29673	16.4	748
29690	16.2	849
29688	14.9	14
29644	14.7	682
29607	12.5	1,516
29650	12.0	766
29687	7.2	940
29681	6.8	734
29662	2.4	82
29615	1.3	168
29645	0.0	0
Greenville	**17.6**	**23,191**

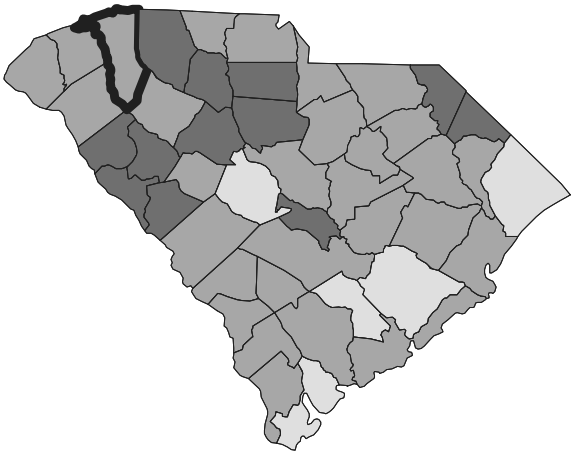
Table 4c. Greenville County, South Carolina, by census tract.

Census tract	%	Number	Census tract	%	Number	Census tract	%	Number
21.05	**72.7**	**913**	13.01	26.4	394	21.03	6.9	85
1	**69.8**	**454**	15.02	25.2	293	30.03	6.9	102
10	**68.6**	**915**	3	24.3	450	29.01	6.8	96
5	**63.8**	**593**	30.05	24.0	231	33.02	6.6	135
11.02	**60.6**	**473**	24.01	22.4	466	36.02	6.1	66
15.01	**59.5**	**1,038**	16	21.5	265	20.01	5.7	71
14	**52.1**	**1,018**	23.01	20.9	369	35	4.9	25
21.08	**51.7**	**502**	40	19.9	337	27	3.8	114
22.02	**50.9**	**521**	25.03	18.5	233	30.07	3.6	30
23.02	**48.0**	**681**	26.04	17.6	292	29.02	3.5	63
4	**47.7**	**482**	39.02	17.3	268	29.03	3.0	76
23.03	**45.9**	**443**	12.02	16.3	374	37.02	3.0	68
2	**44.3**	**148**	32	14.4	321	28.06	2.9	81
25.04	**44.3**	**404**	31	14.1	381	19	2.4	36
6	**43.4**	**155**	12.01	13.7	93	37.04	2.4	40
22.01	**42.8**	**986**	39.04	13.6	216	18.03	2.0	31
8	**38.5**	**238**	24.02	11.8	146	30.06	2.0	48
21.06	**37.3**	**628**	36.01	11.5	194	18.02	1.7	60
21.04	**37.0**	**358**	39.03	11.5	146	18.05	1.6	35
9	**36.7**	**244**	20.02	10.2	160	18.06	1.1	30
25.05	**36.4**	**535**	37.05	9.8	86	28.04	0.8	6
21.07	**35.2**	**481**	38.02	9.6	158	26.02	0.7	16
7	**34.1**	**299**	30.04	9.5	210	28.03	0.7	15
13.02	**33.9**	**289**	37.01	9.0	133	28.05	0.7	12
33.01	**27.7**	**572**	17	8.6	166	28.07	0.6	13
41	**27.5**	**591**	25.01	8.4	133	18.04	0.5	5
11.01	**27.3**	**462**	26.01	8.3	253	26.05	0.3	6
23.04	26.7	260	20.03	7.9	112			
34	26.7	150	38.01	7.6	113	**Greenville**	**17.6**	**23,191**

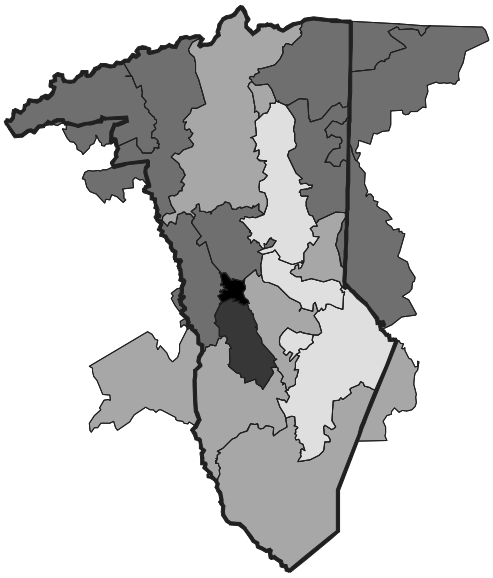
Source of data: 1990 U.S. Census

Figure 2. Housing Built Before 1950 in South Carolina: Geographic Analysis at Three Different Levels-County, Zip Code, and Census Tract.

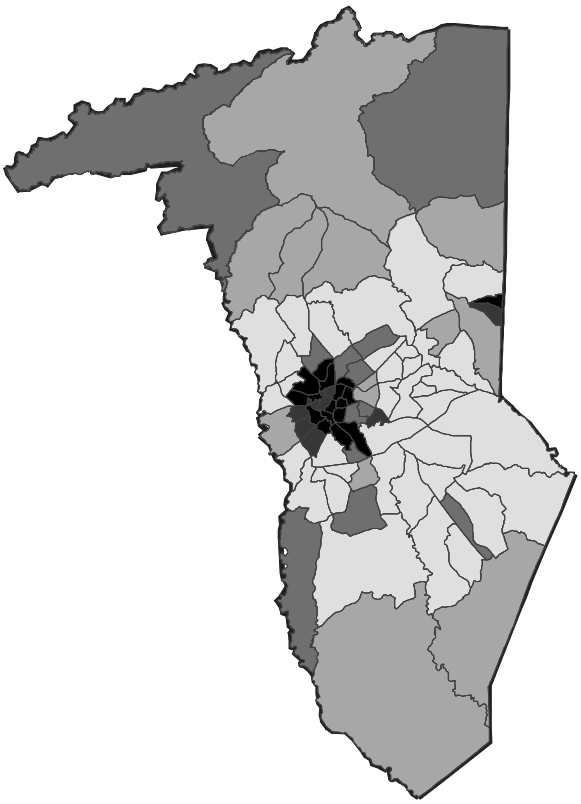
Counties in South Carolina

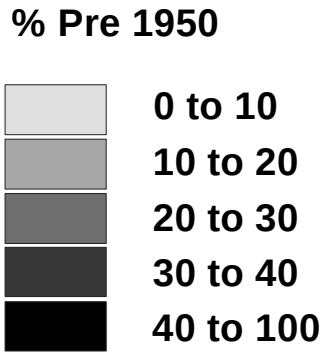


Zip Codes in
Greenville County, S.C.



Census Tracts in
Greenville County, S.C.





- By improving access to needed screening for children without access to routine health care services. It has been shown that some groups of poor and lead-exposed children do not regularly have access to medical services.[53]
- By increasing screening in those geographic areas where high percentages of children are living in poverty, as shown by U.S. Census or other data, and carefully examining the outcome of such enhanced effort.

Screening minority children. Membership in some racial or ethnic minority groups is a marker for increased risk of exposure to lead and elevated BLLs. For example, black children are at much higher risk for elevated BLLs than other children. Phase 1 of NHANES III showed that 21.6% of 1- and 2-year-old black children had elevated BLLs compared with 9% of 1- and 2-year-old white children.[3] Public health officials should determine whether children in high-risk racial and ethnic groups are receiving adequate screening and, if not, should develop additional ways to provide screening for these children.

Some children who are members of minority groups may be at increased risk of lead exposure from the use of traditional remedies, cosmetics, or ceramicware containing lead. For example, traditional remedies used by some Mexican-American and other (e.g., Southeast Asian) populations can cause substantial BLL elevations in some children.[54] Mexican-American children may also be exposed to other sources of lead, including bean pots and ceramicware.[55] These exposures should be specifically considered in populations with substantial numbers of Mexican-American children or with other at-risk ethnic groups.

Screening children who live near industrial lead sources or whose parents are occupationally exposed to lead. Children who live near operating or abandoned industrial sites or waste-disposal sites have sometimes been found to have increased risk of elevated BLLs. In addition, parents who work in lead industries sometimes expose their children to lead that they carry home on their clothes or persons.[56] Industries most often associated with take-home lead exposures are primary or secondary lead and copper smelting, battery manufacturing, battery recycling, construction, pottery work, stained-glass making, radiator repair, electronic-components manufacturing, gold assay labs, and gold and silver recovery. In places where take-home lead exposure is a concern, screening of potentially exposed children and other measures to prevent such exposures should be considered.

Criterion 3: Responses to a personal-risk questionnaire. In recommendation areas with targeted screening, there will be children who do not live in a high-risk geographic area and who do not belong to a high-risk group. Nevertheless, some of these children may be at risk for lead exposure and will need to be screened. To identify children who are at risk but who cannot be identified on the basis of their inclusion in a larger group, child health-care providers should administer a personal-risk questionnaire to the parents or guardians of each 1- and 2-year-old child and should screen children when any answer to a question is "yes" or "unknown."

CDC's recommended basic personal-risk questionnaire is included in this chapter. Public health officials and child health-care providers should assess the usefulness of this personal-risk questionnaire in their recommendation areas and modify it accordingly. Several studies have shown that it is possible to improve the sensitivity or the specificity of the questionnaire by including questions about potential local exposures or by eliminating questions that are not locally relevant.[57]

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[53] Colorado Department of Public Health and Environment, 1996; Daniel K, Sedlis MH, Polk L, Dowuona-Hammond S, McCants B, Matte T, 1990.

[54] See Appendix A.6.

[55] Centers for Disease Control and Prevention, 1993.

[56] U.S. Department of Health and Human Services. Report to Congress on Workers' Home Contamination Study conducted under the Worker's Family Protection Act (29 U.S.C. 671a).

[57] U.S. Department of Health and Human Services. Report to Congress on Workers' Home Contamination Study conducted under the Worker's Family Protection Act (29 U.S.C. 671a); Diermayer M, Hedberg K, Fleming D, 1994; Rooney BL, Hayes EB, Allen BK, Strutt PJ, 1994;

The Basic Personal-Risk Questionnaire[58,59]

1. Does your child live in or regularly visit a house that was built before 1950?[60] This question could apply to a facility such as a home day care center or the home of a baby-sitter or relative.
2. Does your child live in or regularly visit a house[61] built before 1978 that is being or has recently been renovated or remodeled (within the last 6 months)?
3. Other questions relating to known locally specific exposures (if applicable).[62]

Tejeda DM, Wyatt DD, Rostek BR, Solomon WB, 1994; Schaffer SJ, Szilagyi PG, Weitzman M,1994; Binns HJ, LeBailly SA, Poncher J, Kinsella R, Saunders SE, Pediatrics 1994; Schaffer SJ, Kincaid MS, Endres N, Weitzman M, 1996.

[58] The personal-risk questionnaire is recommended for the following reasons:

Predictive value. Living in or being exposed to renovations of older housing has been associated with an increased risk for elevated BLLs among children in many, but not all, studies. (The following studies showed an association: Gemmel D, 1995; U.S. Department of Health and Human Services. Report to Congress on Workers' Home Contamination Study conducted under the Worker's Family Protection Act (29 U.S.C. 671a); Diermayer M, Hedberg K, Fleming D, 1994; Rooney BL, Hayes EB, Allen BK, Strutt PJ, 1994; Tejeda DM, Wyatt DD, Rostek BR, Solomon WB, 1994; Schaffer SJ, Szilagyi PG, Weitzman M, 1994; Binns HJ, LeBailly SA, Poncher J, Kinsella R, Saunders SE, 1994; Schaffer SJ, Kincaid MS, Endres N, Weitzman M, 1996; Diermayer M, Barnett M, Leiker R, Hedberg K, Fleming D, 1994. The following studies did *not* show an association: Robin LF, Beller M, Middaugh JP, 1994; Casey R, Wiley C, Rutstein R, Pinto-Martin J, 1994.)

Educational value. The questions give health-care providers an opportunity to discuss the hazards of deteriorating paint in older housing and of improperly performed home renovations, whether or not the child has an elevated BLL at the time of the visit.

Sensitivity in predicting markedly elevated BLLs. Results of some studies suggest that questionnaires are more sensitive for identifying children with more severe BLL elevations, i.e., ≥ 15 µg/dL or ≥ 20 µg/dL, than for identifying children with BLLs in the range of 10-14 µg/dL (see Schaffer SJ, Szilagyi PG, Weitzman M, 1994; Nordin JD, Rolnick SJ, Griffin JM, 1994).

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[59] The questionnaire may be used to stimulate dialogue between the health-care provider and parent and to allow for judgment about whether or not screening is appropriate for an individual child. Asking the questions provides an opportunity to educate families and may provide additional information for decision making about screening.

The recommended personal-risk questionnaire differs from the earlier version (i.e., that in the 1991 edition of *Preventing Lead Poisoning In Young Children*). Only two standard questions are now recommended, rather than the five previously recommended, for the following reasons:

- To increase the focus on lead-based paint hazards in older housing rather than on other less important sources of lead exposure.
- To make the questionnaire less burdensome for families and providers.
- To reduce the use of questions that do not have the ability, when used routinely, to predict increased risk for elevated BLLs (e.g., questions on industrial exposures).
- To reduce the number of children needlessly screened on the basis of the questionnaire. The earlier five-question document (with or without minor modifications) typically results in BLL screening of many children even in places where prevalence is low. For example, in Alaska, about 65% of children were defined as "high risk" on the basis of answers to this questionnaire, but only 4 of 631 of these "high-risk" children had elevated BLLs, and none required environmental or medical follow-up services (see Robin LF, Beller M, Middaugh JP, 1994).
- To delete references to deteriorated paint in order to make the questionnaire easier to administer and answer and to avoid subjective judgments about what constitutes "peeling or chipping paint" (see Binns HJ, LeBailly SA, Poncher J, Kinsella R, Saunders SE, 1994).

[60] A cut-off date for age of housing of 1950 is recommended in Question 1 of the personal-risk questionnaire for reasons that are discussed in footnote 36. However, on the basis of local circumstances, earlier housing-age cut offs (such as 1940) or more recent cut-offs (such as 1960 or 1978) could be chosen.

Earlier cut-off dates (e.g., 1940) should result in a questionnaire that is more specific (i.e., fewer children would be identified as "high risk," but more of these would have elevated BLLs). Later cut-off dates (e.g., 1960) should be more sensitive (i.e., more children would be identified as "high risk," but fewer of them would have elevated BLLs; however, more children with elevated BLLs would be identified).

The broader approach to age of housing recommended in Question 2 is supported by the fact that lead was used in some residential paint until 1978, and thus, lead hazards could be created from improperly performed renovation in housing built until that year.

[61] The cut-off point of 1978 is used to increase the likeli-

hood of identifying children who may be exposed to lead from recent, ongoing, or contemplated renovations, which are shown in many studies to be associated with an increased risk for elevated BLLs in children. (See Gemmel D, 1995; U.S. Department of Health and Human Services. Report to Congress on Workers' Home Contamination Study conducted under the Worker's Family Protection Act [29 U.S.C. 671a]; Diermayer M, Hedberg K, Fleming D, 1994; Rooney BL, Hayes EB, Allen BK, Strutt PJ, 1994; Tejeda DM, Wyatt DD, Rostek BR, Solomon WB, 1994; Schaffer SJ, Szilagyi PG, Weitzman M, 1994; Binns HJ, LeBailly SA, Poncher J, Kinsella R, Saunders SE, 1994; Schaffer SJ, Kincaid MS, Endres N, Weitzman M, 1996; Diermayer M, Barnett M, Leiker R, Hedberg K, Fleming D, 1994.)

[62] Examples of additional questions for the personal-risk questionnaire:

Personal or family history of lead poisoning

- Does your child have a brother, sister, housemate, or playmate who is being treated or receiving follow-up care for lead poisoning?
- Have you ever been told that your child has lead poisoning?

Occupational, industrial, or hobby exposures to lead

- Does your child live with an adult whose job or hobby involves exposure to lead?
- Does your child live near an active lead smelter, battery recycling plant, or other industry likely to release lead into the environment?

Other Sources of Lead Exposure

- Does your child live within one block of a major highway or busy street?
- Do you use hot tap water for cooking or drinking?

Cultural Exposures To Lead

- Has your child ever been given home remedies (azarcon, greta, pay looah)?
- Has your child been in Latin America?
- Has your child ever lived outside the United States?
- Does your family use pottery or ceramics for cooking, eating, or drinking?

Poverty

- Does your family receive medical assistance?
- Do you rent your home?
- Are you or the child's parents migrant farm workers?
- Have you recently moved?

Behavior

- Have you seen your child eat paint chips?
- Have you seen your child eat soil or dirt?

Associated Medical Problems

- Have you been told that your child has low iron?

Thus, in recommendation areas where exposure to lead from older housing is unlikely, a personal-risk questionnaire could still be used, but it should include questions about other risk factors, for example, about the use of lead-containing ceramics and folk remedies, or exposures resulting from a parent's occupation.[63]

The use of a personal-risk questionnaire may not be helpful for identifying children who are exposed to lead in recommendation areas in which less than 3% of children have BLLs ≥ 10 µg/dL. Studies of the use of a personal-risk questionnaire in Salt Lake City[64] and Alaska[14] showed that large numbers of children were screened on the basis of responses to the questionnaire, but few or no children were identified who required individual attention for lead exposure.

In recommendation areas with public health circumstances that indicate very little likelihood that children are being exposed to lead (e.g., extremely low prevalence rates, lack of identified sources of lead exposure) health departments should consider methods other than the use of the personal-risk questionnaire for identifying children who need screening (e.g., periodic focused surveys,[65] routine collection and review of BLL testing data from laboratories, public health alerts to parents and providers about newly identified sources of lead exposure.) Recommendations from the health department should not prevent providers from screening children in any instance where a parent or a child health-care provider believes that there is potential risk for lead exposure.

[63] Appendix A.5 details occupational and hobby risk factors for lead exposure; Appendix A.6 shows risk factors for and sources and pathways of lead exposure; and footnote 62 contains examples of additional questions that can be added to the questionnaire to suit local conditions.

[64] T. Schlenker, M.D., Salt Lake City/County Health Department, personal communication, 1996.

[65] Centers for Disease Control and Prevention, In press.

Implementing a lead screening recommendation

There are two steps in the implementation process: *communicating* the screening recommendation and *monitoring* and *evaluating* the effectiveness of screening. Communicating the recommendation will require the participation of all the groups involved in the planning process, whereas the monitoring and evaluation process should be led by state and local public health officials.

Step 5: Communicate the screening recommendation

Communicating the screening recommendation requires active participation of public health agencies and health-care providers who have worked together throughout the planning process. For example, health-care provider groups that have been represented in the planning process should actively support the recommendations and use newsletters and meetings to explain the foundations and the particulars of screening recommendations, in order to garner support among child health-care providers.

For a screening recommendation to be effective, those who will carry it out must be able to understand it and find it easy to use. They also need to understand the basis on which the recommendation has been made and how it can be altered as necessary in the future.

Public health officials and those who have participated in developing recommendations should scrutinize the screening recommendation before it is released, according to the following questions:

- Is the recommendation understandable? The recommendation should be clear and direct.
- Is it easy to use? The recommendation should include specific guidance for child health-care providers.
- Does it make sense? The recommendation should include a brief explanation of why it makes sense for the recommendation area.[66]

[66] See the end of this chapter for a sample "Dear Colleague" letter recommending targeted screening for a hypothetical metropolitan area that takes into consideration these three questions.

Step 6: Monitor screening and evaluate its effectiveness

Public health officials should make a plan for monitoring and evaluating the effectiveness of screening recommendations. Monitoring (surveillance) systems that collect BLL screening data are important aspects of this process. CDC provides assistance to states and locales in determining data needs and developing BLL monitoring systems. Public health officials should also decide how they will revise screening recommendations on the basis of changing public health situations, additional information, and local input.

Changing public health situations

With time, housing in a recommendation area can deteriorate, creating increased potential for exposure to lead. Alternatively, housing can improve, reducing exposures to lead and the need for screening. Similarly, the demographic character or socioeconomic status of residents of a recommendation area can change. Thus, over time, screening efforts may need to expand or contract.

Additional information for making decisions

It is expected that screening recommendations that are developed in an inclusive manner and based on local conditions will lead to more screening in many places. With the increase in screening, the opportunity to collect and analyze BLL data will expand, making possible better estimates of BLL prevalence, and more information will be available for use in refining the recommendations and the personal-risk questionnaire. Improved estimates will make it possible to refine recommendations to providers about which children should be screened.[67]

Better tools for analyzing and presenting data will also become available. Multivariable models and analyses will allow better prediction of

[67] See, for example, the "Dear Colleague" letter at the end of this chapter, which shows the use of blood lead prevalence data in developing and communicating screening recommendations.

risks for lead exposure. Some of these models have been described[68] and others will be developed. As they are developed, they must be validated by collecting and analyzing BLL data.

A readily available computer technology, geographic information systems (GIS), can make data easier to use. Computer-generated maps showing distributions of pertinent risk factors and BLLs in particular populations could be useful for health officials in making decisions about screening and in explaining and gaining support for these decisions from various concerned groups.

Local input

Local health-care delivery organizations, such as managed care organizations, may perform blood lead surveys of their patient populations. (See footnote 33 for a discussion of why such surveys should not be the sole basis for making screening recommendations.) The data from such surveys must be carefully evaluated and can enhance the local decision-making process.

In addition, local public health personnel may have a strong sense of the geographic boundaries of pockets of potential lead exposure in their recommendation areas and may choose to refine a screening recommendation by focusing efforts (e.g., door-to-door screening, intensified education, primary prevention efforts) on a specific geographic area.

Some local issues may be more challenging than others for health officials charged with deciding what is best for entire populations of children. It is recommended that officials develop a review process to use with concerned groups who wish to vary from the screening recommendation that has been made.[69]

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[68] Sargent JD, Brown MJ, Freeman JL, Bailey A, Goodman D, Freeman DH, 1995.

[69] In Denver, childhood lead poisoning was widely perceived not to be a problem. After CDC's 1991 recommendation for universal screening was released, screening was begun in a group of clinics serving predominantly poor children who received Medicaid benefits.. These clinics consecutively screened nearly 3,000 children who lived in central Denver and found that approximately 3% of these children had elevated BLLs and that 0.3% had BLLs of ≥ 20 µg/dL. Personal-risk questionnaires did little or nothing to increase the yield of screening.

In conjunction with local community groups and local child health-care providers, the health department attempted to locate "pockets of risk." They selected a group of nine census tracts that had 1) high percentages of older housing, 2) high percentages of households below the poverty level, and 3) an apparent cluster of children with elevated BLLs as shown in BLL surveillance data.

The health department performed a door-to-door survey of children living in this potentially high-risk area and tested 173 children ranging in age from 12-35 months who lived in housing built before 1978. Of these, 65% lived in homes built before 1920; almost 60% had not previously had a BLL measurement, and about 25% had no regular source of medical care. Sixteen percent

of the children in the survey had elevated BLLs, and 2.9% had BLLs of at least 20 µg/dL (see Colorado Department of Public Health and Environment, 1996).

As a result of this survey, the health department has recommended that children living in this high-risk area be routinely screened. The health department is also attempting to define other pockets of risk elsewhere in Colorado.

Lessons from this process include the following:

- Constructive collaboration between community groups, pediatricians, and health departments is possible and useful.
- It is possible to define pockets of risk on the basis of available data.
- The implementation of routine universal screening recommendations may miss at-risk children and may screen large numbers of children who are not at risk.
- Routine clinic-based approaches to either universal or targeted screening may fail to reach children who do not have a routine source of care (see Norman EH, Bordley C, Hertz-Picciotto I, Newton DA, 1994).

Sample "Dear Colleague" Letter

Date

Dear Colleague:

The following recommendation on blood lead screening of young children who reside in River City and River County take effect immediately:

Blood lead screening should be performed for the following:

1. All children who live in the following four zip codes:
   12345
   12346
   12348
   12350

2. All children who are enrolled in or eligible for Medicaid.

3. All children whose parent or guardian answers "yes" or "unknown" to either question in the following personal-risk questionnaire:

   Question 1:
   "Older houses sometimes have lead in their paint, and this lead can accidentally harm children. Does your child live in or regularly visit a house that was built before 1950?" (This question could apply to a facility such as a day care center or preschool or the home of a baby-sitter or relative.)

   Question 2:
   "Does your child live in or regularly visit an older house that has recently been or is in the process of being renovated or remodeled? By recently, I mean within the last 6 months, and by older, I mean a house built before 1978."

A determination about whether or not a child needs lead screening, followed by appropriate blood lead testing, should be made for all children at around ages 12 and 24 months and for children up to age 72 months with no previous history of either having been tested or of parents having answered the personal-risk questionnaire. Screening can be performed using venous or capillary sampling. (See attachments 1 and 2.)

We provide several attachments relevant to these recommendations:
- Attachment 1-Questions and answers about recommendations.
- Attachment 2-Protocol for performing blood lead testing.
- Attachment 3-Protocol for follow-up care of children with elevated blood lead levels.
- Attachment 4-Map of River City and River County showing zip codes with areas of older housing.
- Attachment 5-Map of River City and River County showing zip codes where children with elevated blood lead levels have been identified.

If you have any questions or comments about these recommendations, please call our Lead Screening Recommendation Hotline at (999) 123-4567 between 8 a.m. and 6 p.m., Monday through Friday.

Sincerely,

A.B. Cee
Health Commissioner
River City

D.E. Eff
Health Commissioner
River County

Attachments

Editors' Note: Attachments 2-5 are not included in CDC's recommendations.

Attachment 1: Some Questions and Answers About the Blood Lead Screening Recommendation for River City/River County

My practice is very busy. How might I easily decide which children automatically need lead screening and which I need to administer a questionnaire to first?

For all children aged 12-72 months, have receptionist check the child's zip code of residence and indicate whether the child lives in one of the four zip codes (12345, 12346, 12348, 12350). In addition, have receptionist determine the child's insurance status and indicate whether the child is enrolled in Medicaid.

Children in these four zip codes or those enrolled in Medicaid should receive a blood lead test at approximately 12 months and 24 months of age or once between the ages of 25 and 72 months if they have not been screened previously. Parents or guardians of all other children should be administered the questionnaire, and if the answer to any question is "yes" or "unknown," the child should be given a blood lead test.

In addition, we recommend that you evaluate and consider for screening any child whose parent or guardian requests such testing.

Should I administer the questionnaire for all children aged 12-72 months or for just those who are around 12 and 24 months old?

Parents or guardians of children living outside the four zip codes and who are not receiving Medicaid benefits should be administered the questionnaire, and appropriate blood lead testing of these children should be done at around 12 and 24 months of age. You may also administer the questionnaire to parents or guardians of children 36-72 months of age who have no previous history of either having been given the questionnaire or whose children have not had blood lead tests. Perform blood lead testing when the answer to any question on the questionnaire is "yes" or "unknown."

What are the screening recommendations based on?

Children who live in older housing or have other risk factors for lead exposure need to be screened for lead. The River City/River County area is considered to have only a moderate amount of older housing. Some 20% of our housing was built before 1950, as compared with 27%, the proportion of housing built

before 1950 in the entire United States. In our area, four zip codes (12345,12346, 12348, and 12350) contain most of our older housing (see Attachment 4).

In addition, we have screening test results on a high percentage of 1- and 2-year-old children in the River City/River County area, and these results indicate that most children with elevated blood lead levels live in these four zip codes (see Attachment 5).

Chapter 4. General Lead Poisoning Prevention Guidelines for Child Health-Care Providers

Introduction

This chapter describes the roles and responsibilities of child health-care providers in identifying and caring for children with elevated BLLs.

Child health-care providers should consider blood lead testing when children have unexplained symptoms or signs that are consistent with lead poisoning, including seizures, other neurological symptoms, abdominal pain, growth failure, developmental delay, attention deficit, hyperactivity, other behavior disorders, school problems, hearing loss, or anemia.

The care of children with elevated BLLs is uniquely multidisciplinary and requires close coordination between child health-care providers and public-sector agencies. Therefore, this chapter briefly describes aspects of the care of children with elevated BLLs that are typically performed by people other than child health-care providers. These aspects include coordinating follow-up care activities and providing environmental and social follow-up care. The important point for child health-care providers is that they should be aware of their reponsibilities and how these are part of complete follow-up care for those children whom they identify as having elevated BLLs.

Both the coordination of care of children with elevated BLLs and the provision of follow-up services to families in the home are typically performed by health department personnel. However, these functions are changing now that more people are enrolled in managed care plans, and many health departments are moving out of their role of delivering direct services. Thus, the following discussion outlines functions that should be performed in caring for a lead-exposed child without specifying who should perform those functions.

Health-care providers have the following responsibilities in preventing childhood lead exposure and treating it when it occurs:

Obtain and Use Information Provided by the State or Local Public Health Agency

Child health-care providers, either individually or through their organizations, should contact the state or local public health agency for information on childhood lead poisoning, including screening recommendations, parent-education materials, and follow-up care protocols.

Child health-care providers should follow health department recommendations on screening and other lead poisoning prevention practices.

Provide Anticipatory Guidance about Lead Hazards

Health-care providers should provide anticipatory guidance to families during routine prenatal and preventive care in order to reduce children's exposure to lead. Anticipatory guidance should include information about the following:

- The hazards of deteriorating lead-based paint in older housing and how to reduce these hazards.[70]
- The dangers of improper renovations of homes containing lead-based paint. Some residential paint contained lead until 1978. Before they renovate their homes, parents should determine whether or not those homes contain lead-based paint.
- Other locally relevant lead exposure sources such as lead-containing folk remedies or lead-containing ceramicware.

Anticipatory guidance should be provided prenatally and should be emphasized when chil-

[70] Housing built before 1950 is most dangerous; see footnote 36.

dren are from 3 to 6 months of age. In addition, health-care providers should provide education at health supervision visits when children are ages 1 and 2 or when providers administer the personal-risk questionnaire to the children's parents or guardians.[71]

Provide Appropriate Routine Blood Lead Screening

Child health-care providers should follow health department screening recommendations. The process that health departments should use in developing screening recommendations is described in chapter 3. The following is an overview of important aspects of these recommendations:

Universal screening

In areas where universal screening is called for, a basic health department recommendation would call for screening all children at ages 1 and 2[72] and all children 36-72 months old who have never had a BLL test. (Children with a clinical indication for a BLL test should be tested at the time the indication is identified.)

Targeted screening

In areas where targeted screening is called for, a basic health department recommendation would provide criteria for selecting children who need screening, and for screening these children at the same ages as recommended in the universal screening recommendation above. The selection criteria would usually include one or more of the following:

- Residence in a high-risk zip code or geographically defined neighborhood.
- Belonging to a high-risk population group, such as children living in poverty.

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[71] **Rationale For Timing of Anticipatory Guidance.** We suggest emphasizing anticipatory guidance at 3-6 months because education at these times might provide an opportunity to prevent some of the increase in BLLs that often occurs during a child's second year of life.

BLLs typically increase during the second year of life because children have more access to lead hazards due to their increased mobility and because they ingest more lead as a result of normal hand-to-mouth activity (see National Research Council, 1993; Clark CS, Bornschein RL, Succop P, Que Hee SS, Hammond PB, Peace B, 1985.)

[72] CDC recommends screening children at ages 1 and 2 for the following reasons:

- Young children are more likely to be exposed to lead than older children (see Brody DJ, Pirkle JL, Kramer RA, et al, 1994; Clark CS, Bornschein RL, Succop P, Que Hee SS, Hammond PB, Peace B, 1985).
- The developing nervous systems of young children are more susceptible to the adverse effects of lead than are the nervous systems of older children or adults.
- Surveillance data from Rhode Island (P. Simon, M.D., S. Feeley, M.P.H., personal communication, Rhode Island Department of Health, 1996) and other data suggest that previous BLL results are useful in predicting future BLL tests. In Rhode Island, older children who have never been previously screened commonly have elevated BLLs. However, after children's test results were negative for elevated BLLs at approximately 12 and 24 months of age, the children were unlikely to be subsequently identified with elevated venous BLLs.
- Among Rhode Island children not tested until 25 to 36 months of age, 26% subsequently had at least one elevated BLL. Among children not tested until 36 months of age or later, 18% subsequently had at least one elevated BLL.
- On the other hand, children in Rhode Island whose BLLs were not elevated at approximately 12 and 24 months of age were unlikely to have subsequent BLL results that required individual medical or environmental management. After two screening tests were not elevated, fewer than 10% of children had a subsequently elevated venous BLL, and less than 1% had a subsequent venous BLL of ≥ 20 µg/dL.
- Risks for a subsequently elevated BLL after a single nonelevated BLL at either approximately 1 or 2 years of age were intermediate between these values.

Note: Rhode Island is a state with known high prevalences of elevated BLLs (see Centers for Disease Control and Prevention, 1995) and is among those states in the nation with the highest concentrations of housing built before 1950 (see Table 1, Chapter 1). It is likely that many places would have lower yields of positive results from screening tests performed after two negative tests. However, data from Rhode Island may be applicable to other high-risk children and places.

- Parents answer "yes" or "unknown" to questions on a personal-risk questionnaire.

Living in a high-risk zip code or neighborhood.

In some settings, the state or local health department will recommend screening of children who live in high-risk areas. For example, it may be necessary to screen children who live in certain zip codes.

Belonging to a high-risk population group.

Poor children and children who are members of some racial or ethnic minority groups (e.g., black children, Hispanic children, Asian-American children), and children of occupationally exposed adults are at higher risk for lead exposure than other children.[3] The health department may make recommendations to increase screening among children in one or more of these groups.

Having individual risk factors for lead exposure.

Individual risk factors can be determined by assessing children at ages 1 and 2 using a personal-risk questionnaire. The health department will provide a basic questionnaire such as that shown below, or a questionnaire that is more specific in soliciting information about local risk factors.

Child health-care providers may find it useful to administer the questionnaire again at times when they suspect that the family's situation may have changed in a way that suggests increased risk for lead exposure.

The Basic Personal-Risk Questionnaire[73]

1. Does your child live in or regularly visit a house that was built before 1950? This question could apply, for example, to a facility such as a home day care or the home of a babysitter or relative.

2. Does your child live in or regularly visit an house built before 1978 that is being or has recently (within the last 6 months) been renovated or remodeled?

3. Other questions relating to known locally specific exposures.

If the answers to the questions are "no," then a screening test is not required, although the provider should explain why the questions were asked in order to reinforce anticipatory guidance. If the answer to either question is "yes" or "unknown," a screening test is indicated.

Specimen for Blood Lead Screening

Screening should be done using a blood lead measurement with either a venous blood or capillary (fingerstick) specimen. The choice of screening method (venipuncture or fingerstick) should be determined by the test's accuracy, the availability of trained personnel, convenience, and cost.[74]

Perform Additional BLL Testing When There Are Indications for Doing So

BLL testing in addition to routine screening may be indicated in a variety of clinical situations:

- Children whose risk status has increased (e.g., children who have moved to older housing,

[73] The state or local health department may recommend alternative or additional questions based on local conditions.

[74] Capillary sampling for BLL measurement can perform well as a screening tool. Several studies have now demonstrated that carefully done fingerstick sampling overestimates BLLs obtained by venipuncture by an average of 1µg/dL (see Schonfeld DJ, Cullen MR, Rainey PM, et. al, 1994; Schlenker TL, Johnson FC, Mark D, et al, 1994). However, BLLs obtained by capillary samples can be falsely high if they are contaminated by lead dust on a child's finger (see Parsons PJ, in press). Thus, capillary samples require careful attention to finger cleaning. A procedure for collecting fingerstick specimens with minimum contamination is described in Appendix B.2.

been exposed to the renovation of an older home, or moved to a recommendation area with a higher prevalance of older homes) require additional BLL testing.

- Sometimes it may be useful to administer the personal-risk questionnaire to parents of a child who is outside of the usual ages for screening when a change in the child's exposure to lead is suspected. Older children with excessive mouthing behavior and who are potentially exposed to lead should have BLL testing.

Parents may express concern about lead exposure and request testing. Consideration should be given to performing BLL testing in response to parental concern about lead exposure.

Provide Clinical Management of Children with Elevated BLLs

Children with positive screening tests can require -

- Diagnostic testing.
- Follow-up testing at appropriate intervals.
- A clinical evaluation.
- Additional follow-up services.
- Chelation therapy.

Interventions that are recommended for children with single elevated screening tests include family education about lead poisoning, diagnostic BLL testing, and sometimes other services.

Diagnostic and follow-up testing.

Diagnostic testing of children with elevated screening test results should occur according to the schedule in Table 5.[75] The higher the lead level found by the screening test, the sooner a diagnostic test should be performed.

[75] Extra effort is sometimes required to obtain a diagnostic test, especially on children from high-risk families that have many other problems to deal with. These children may need to be visited in the home to obtain a specimen.

Table 5. Schedule for Diagnostic Testing[76] of a Child with a Positive Screening Test for Lead in Blood.[77]

If the Result of Screening Test (ug/dL) is:	Perform Diagnostic Test for Lead on Venous Blood within[78]
10 - 14	3 months
15 - 19	2 months
20 - 29	1 month
30 - 44	1 week
45 - 69	48 hours
≥ 70	Immediately as an emergency laboratory test

- Children with diagnostic BLLs of ≥ 20 µg/dL should receive clinical management.
- Children with diagnostic BLLs of 10-14µg/dL should have at least one follow-up test within 3 months. Children with diagnostic BLLs of 15-19 µg/dL should have a follow-up test within 2 months. If the result of the follow-up is ≥ 20 µg/dL, or if the child has had two or more venous BLLs of 15-19µg/dL at least 3 months apart, the child should receive clinical management.
- If the diagnostic BLL test does not require the child to receive clinical management, the child should be retested in 1 year, and the clinician should treat the retest as if it were a new screening test.

Clinical management should include periodic BLL measurements to monitor the effectiveness

[76] A diagnostic test is defined as the first venous blood lead test performed within 6 months on a child who has previously had an elevated blood lead level on a screening test.

If the diagnostic test for lead is not performed within 6 months of the screening test, the diagnostic test should be treated as a new screening test. Decisions about the need for follow-up testing should be made on the basis of the result of the new test and not on the basis of the original screening test.

[77] This schedule applies to screening tests performed on capillary or venous blood.

[78] If there is reason to believe that the BLL may be increasing rapidly, or if the child is younger than 1 year of age, consider performing the diagnostic test sooner than indicated.

of educational, environmental, and pharmacologic interventions in lowering a child's BLL. Early in the course of treatment or while a child is receiving chelation therapy, the child should be tested frequently (approximately every month) to evaluate the trend and stability of BLLs.

A child whose BLL has not increased in 6 months and who has had no new environmental exposures can be tested less often, for example, approximately every 3 months. Stopping routine BLL measurements can be considered when the child's BLL has remained at < 15µg/dL and lead hazards in the child's environment have been removed.

Diagnostic BLLs with associated recommended follow-up services are shown in Table 6.

Clinical evaluation.

All children with at least one venous BLL of ≥ 20 µg/dL or two venous BLLs of 15-19 µg/dL at least 3 months apart should receive a clinical evaluation. A clinical evaluation contains both medical and environmental components:

1. **Take a medical history about the following:**
   - The presence or absence of clinical symptoms.
   - The child's developmental history, with particular attention to language development, ability to concentrate, and other developmental aspects that can be adversely affected by lead.
   - Mouthing activities.
   - Pica.
   - Nutritional status.
   - Previous BLL measurements.
   - Family history of lead poisoning.

2. **Take an environmental history about the following:**
   - Age and condition of the child's primary residence and other places that the child spends time (including secondary homes and day care centers). Determine whether the child may be exposed to lead-based paint hazards at any or all of these places.
   - Occupational and hobby histories of adults in the household or other places the child spends time to determine whether the child is being exposed to lead from an adult's workplace or hobby.[79]
   - Other potential sources of lead exposure.[80]

3. **Evaluate the child's nutritional status.** Nutritional status should be determined by dietary history, and iron status should be evaluated using appropriate laboratory tests. Identified nutritional problems should be corrected.
   - Deficiencies of calcium and iron increase lead absorption or toxicity in children and laboratory animals.[81]
   - A diet high in fat may also result in increased lead absorption.[82]
   - More absorption of lead occurs when the stomach is empty.[83]

4. **Perform a physical examination**, with particular attention to the neurologic examination and psychosocial and language development. Findings of language delay or other neurobehavioral or cognitive problems should prompt referral to appropriate programs at the time these problems are identified.

Children in whom this evaluation suggests learning problems should be referred to early intervention programs and receive further examinations during the early school years to fa-

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[79] See Appendix A.5 for occupational and hobby sources of lead poisoning.

[80] See Appendix A.6 for sources and pathways of lead exposure.

[81] Mahaffey KR, 1995; Sargent JD, 1994.

[82] Mahaffey KR, 1995; Lucas SR, Sexton M, Langenberg P, 1996.

[83] Mahaffey KR, 1995.

Table 6. Recommended Follow-up Services, According to Diagnostic Blood Lead Level[84]

Blood Lead Level (µg/dL)	Action
< 9	Reassess or rescreen as described in the text. No additional action unless exposure sources change.
10-14	Provide education as described in text. Provide follow-up testing as described in text. Provide social services, if necessary.
15-19	Provide education as described in text. Provide follow-up testing as described in text. Provide social services if necessary. If BLLs persist (i.e., 2 venous BLLs in this range at least 3 months apart) or worsen, proceed according to actions listed for BLLs in the range of 20-44.
20-44	Conduct a clinical evaluation as described in text. Conduct environmental investigation and lead-hazard reduction. Provide case management and follow-up testing as described in the text. Provide education as described in text. Provide social services, if necessary.
45-69	**Begin Case Management, Medical Treatment, Environmental Assessment, and Remediation within 48 Hours.** Conduct a clinical evaluation and institute appropriate chelation therapy.[85] Provide education as described in text. Provide social services, if necessary.
≥ 70	**Hospitalize the Child and Begin Medical Treatment Immediately.** **Begin Case Management, Environmental Assessment, and Remediation Immediately.** Conduct a clinical evaluation and institute appropriate chelation therapy.[85] Provide education as described in text. Provide social services, if necessary.

cilitate entry into an appropriate educational program.

[84] Family education and additional BLL testing are warranted by an elevated screening test. Case-management, a clinical evaluation, and environmental investigation may also be performed on the basis of a venous screening test that is ≥ 20µg/dL. However, it is recommended that most interventions be performed on the basis of the diagnostic test (i.e., the first venous BLL test after the screening test). The reasons for this recommendation are discussed in Footnote 86 below.

[85] Chelation therapy must be provided only in a lead-safe environment.

Additional follow-up services for children on the basis of the pattern and trend of BLL tests.[86]

Children with at least one venous BLL of ≥ 20 µg/dL[84] or two venous BLLs of 15-19µg/dL at least 3 months apart should receive, in addition to a clinical evaluation, a home visit by the health department to assess the home for lead hazards and to provide to the family education about lead hazards and how to reduce them.

Chelation therapy, if appropriate.

All children with BLLs of at least 45µg/dL should be treated promptly with appropriate chelating agents. Chelation therapy should only be instituted on the basis of venous blood lead measurements. If a child is found to have an elevated capillary BLL, obtain a second BLL by venipuncture before beginning chelation therapy. Even if the screening test was performed on venous blood, it is preferable to do a second venous test before starting chelation therapy on an asymptomatic child. Regardless of the lead level at which chelation therapy is begun, *chelation therapy should be instituted only if the child's health-care providers can be assured that the child is in a lead-safe environment*. In some cases it may be necessary to hospitalize a child before beginning chelation therapy to ensure that the environment is free of lead hazards.

A child with a BLL of 45-69 µg/dL and symptoms, or with a BLL of ³ 70 µg/dL, with or without symptoms, constitutes a medical emergency. The child should be hospitalized immediately to ensure that chelation therapy is delivered in a lead-safe environment and that the child is monitored for the need for intensive care. Children with BLLs of ≥ 70 µg/dL should have chelation therapy immediately, whether or not symptoms are present.

Guidelines for using chelation therapy to treat children with elevated BLLs have been published by the American Academy of Pediatrics.[5]

Educate Parents About Elevated BLLs.

Families of children with a capillary or venous BLL of ≥10 µg/dL should receive prompt and individualized education on the following topics:

- What the child's BLL is and what it means.
- The potential adverse health effects of the elevated BLL.
- Likely sources of lead exposure and, if any are present, how to reduce exposure to them.
- The importance of good nutrition in reducing the absorption and adverse effects of lead. If there are poor nutritional patterns, discuss the importance of an adequate intake of calcium and iron and encourage regular meals.
- The need for follow-up BLL testing to monitor the child's BLL, as appropriate.
- The results of environmental inspection, if applicable.
- The hazards of improper removal of lead-based paint. Improper removal of lead-based paint can cause greater problems than it solves. Particularly hazardous removal methods include open-flame burning, power sanding, hydro blasting, using methylene chloride-based strippers, and dry sanding and scraping.

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[86] The emphasis on the pattern and trend of BLL results, rather than on single screening-test values, represents a change compared with recommendations in CDC's 1991 guidelines. CDC recommends this change for the following reasons:

- It is relatively common for children to have slightly elevated screening test results that do not persist on additional testing. Managing the care of children on the basis of the pattern and trend of BLL results will 1) decrease the number of follow-up tests for children whose elevated BLLs do not persist, 2) make it possible to avoid some of the consequences of labeling children as having a disease, and 3) reduce the time and resources devoted to managing the care of these children.
- It is prudent to perform at least two BLL tests to ensure that an elevated BLL persists and that interventions are based on a recent BLL before initiating chelation therapy, which can involve side effects, or environmental intervention done on the basis of the BLL (i.e., secondary prevention).

When lead hazards are identified in the homes of young children, these hazards should be reduced, independent of the child's current BLL (i.e., primary prevention should be done).

Education should be reinforced during follow-up visits as needed.

Participate on a Multidisciplinary Team.

Child health-care providers should function as part of a multidisciplinary team that provides appropriate medical, educational, environmental, and social care, as well as case management, which is the coordination of that multidisciplinary care, to children with elevated BLLs.

In this section, we discuss the care of individual children with elevated BLLs that is typically performed by people other than individual child health-care providers.

Case Management (Coordination of Care)

Case management is the formal coordination of the care of a child with a blood lead level that exceeds a specific value-as determined by state or local public health officials-and the assurance that services needed by that child are provided. At a minimum, children with diagnostic venous BLLs of ≥ 20 µg/dL or 2 venous BLLs of 15-19 µg/dL at least 3 months apart should receive case management.

Broad local experience suggests that follow-up services are best carried out by a coordinated, multidisciplinary team whose members may include the child health-care provider, case-management coordinator, community-health nurse or health advisor, environmental specialist, social services liaison, and housing specialist.

Coordinating the care of lead-poisoned children is typically performed by health department personnel. However, specific roles and responsibilities will differ from place to place and should be defined by the health department with input from interested others.

Environmental Services

Identifying and controlling environmental sources of lead and controlling the hazard are the most important aspects of the management of a child with an elevated BLL. Environmental inspection should be performed and appropriate remediation activities undertaken for all children with diagnostic venous BLLs of ≥ 20 µg/dL[84] or with 2 venous BLLs of 15-19 µg/dL at least 3 months apart.

The most common sources and pathways for high-dose lead poisoning in the United States today are lead-based paint and lead-contaminated dust and soil.[87]

Chapter 16 of the Department of Housing and Urban Development (HUD) guidelines[6] provides information on investigating and treating the dwelling of a lead-exposed child.

Detailed instructions for identifying and performing remediation of hazardous paint, dust, and soil are found in the HUD guidelines.[6] In addition, the HUD guidelines contain suggestions for reducing other sources of lead.

Educational Services

Awareness and behavioral change on the part of family members is important for reducing exposure to environmental lead hazards. Education should be provided to all families of children who have positive screening tests and should be reinforced during case management as needed.

Social Services

Many families who have a child with a newly diagnosed elevated BLL will need assistance that includes identifying other service needs of children and their families and removing barriers to those services. Adequate follow-up care for children with elevated BLLs cuts across disciplines and can take place only in the context of a coordinated service-delivery system.

In places where childhood lead exposure is associated with deteriorating homes in economically stressed communities, problems such as poverty, joblessness, substance abuse, domestic and community violence, poor nutrition, and inadequate housing may exist as obstacles to improving the health of a child and family.

Social workers, outreach workers, community health nurses, and community health advisors play essential roles in assessing family needs and assisting families in gaining access to a variety of services. In some instances, existing so-

[87] Sources of lead are listed in Appendix A.6.

cial-service systems may be inadequate, and health-care providers as well as other members of the multidisciplinary team will need to influence public policy so that essential services become available.

Other Services

Existing service-delivery systems often provide support to resolve problems related to childhood lead poisoning. Blood lead testing and medical and nutritional assistance may be available to children enrolled in the Medicaid/Early and Periodic Screening, Diagnostic, and Treatment (EPSDT) Program; the Maternal and Child Health program and the Supplemental Food Program for Women, Infants, and Children (WIC) may also provide these services.

Services are also available for children with developmental delays; the federal statute known as the Individuals With Disabilities Education Act (IDEA) regulates and assists states that provide developmental services for young children.

Housing agencies may provide assistance to families by requiring action on the part of property owners to bring rental properties into compliance with local codes. Families who need legal advice may be eligible for low-cost legal assistance.

Housing or public health agencies may provide assistance to families in securing temporary or permanent lead-safe housing and may also provide information about the rights of tenants (e.g., in some places, local ordinances may prohibit landlords from evicting families with children who have newly identified elevated BLLs).

Maintain An Ongoing Dialogue With Public Health Agencies

Complete laboratory blood lead test requisition slips. Report children with elevated BLLs to your local health authority as required. Provide constructive feedback to your public health agency.

Child-health care providers are an important link in the chain that makes possible public health monitoring of childhood lead poisoning. An increasing number of states require that laboratories report the results of all children's BLL tests, along with important demographic information provided on laboratory test-requisition slips. The child health-care provider who puts accurate and complete information on the lab slip when ordering a BLL test, is performing a critical public health role. Child health-care providers should also be aware of any requirements that they report elevated BLLs of children under their care to the state or local public health agency.

Clinicians and managed care plans should share information that they discover about childhood lead poisoning in their locales so that health departments can improve their understanding of local exposures and ways to manage these lead hazards. It is especially important to notify health departments about unusual sources or pathways that are identified.

It may also be necessary to encourage health departments to adjust screening recommendations either to enhance the identification of lead-poisoned children or to reduce the screening of children who are not exposed to lead.

Chapter 5. Evaluating the Impact of Childhood Blood Lead Screening Recommendations in a Changing Health-Care Delivery System

Evaluating Impact

It is important to know whether or not the screening recommendations are having the desired effect. Are more children who are likely to be exposed to lead receiving blood lead screening, and at the correct ages? Are children with elevated blood lead levels receiving appropriate follow-up services? Are fewer children who are not exposed to lead receiving unnecessary screening? Public health officials and other interested parties will need to determine the answers to these questions.

The process of evaluating the impact of screening recommendations, like the process of developing them, needs to be inclusive. The evaluation process should involve those who are carrying out the recommendations, such as child health-care providers, managed care organizations, and public agencies (for example, Medicaid) as well as representatives of those who need the service, such as community advocates.

There are several approaches to collecting data for such an evaluation. It might be useful to do surveys of child health-care providers in high-risk neighborhoods about knowledge, attitudes, and behaviors in relation to lead screening and of parents about their knowledge concerning lead exposure and screening. Providers or provider groups could perform quality assurance activities or conduct special studies involving chart reviews or other methods.

Direct measurement of the number of children screened and with elevated blood lead levels in a recommendation area could be accomplished either by one or more surveys or through a monitoring (surveillance) system. Some states have established statewide monitoring systems and most of these collect data at the county or city level that would be extremely useful for evaluation.[88]

The Changing Health Care Delivery System

In many places, evaluation of screening recommendations will take place in the context of a health-care delivery system that is rapidly changing, making the job of evaluation more challenging.

Historically, public health agencies in some places have been the major provider of childhood lead screening, laboratory analysis, and follow-up care; in many more places, public agencies have provided these services as a last resort for low-income people. Now there is a nationwide trend toward decreasing public-sector delivery of health care services. This trend is marked by increased enrollment of Medicaid recipients in private-sector managed care organizations.

The resulting dispersion of lead screening, laboratory analysis, and follow-up services among many providers makes the job of monitoring more complicated. At the same time, both managed care organizations and state Medicaid agencies are now likely to have heightened interest in evaluating the impact of the lead screening recommendations and may have data and staff resources to devote to the evaluation process.

State Medicaid agencies write contracts with managed care organizations for delivery of services to Medicaid enrollees and are developing ways to monitor these contracts that are useful to both parties. These agencies and organizations will be important allies in evaluating the impact of lead screening recommendations.

[88] Good surveillance is based on good data from laboratory reports.

Chapter 6. Childhood Lead Poisoning Prevention Research Priorities

There is currently much good-quality research on the adverse health effects that can result from lead exposure. However, research on effective prevention approaches is more limited. Important research is under way to address this limitation. Additional information will allow a continuing refinement of lead poisoning prevention strategies.

First, additional studies of the *effectiveness of interventions for preventing or reducing elevated BLLs and their sequelae* in children are needed. These should include, at a minimum, studies of 1) the effectiveness and cost effectiveness of interventions aimed at reducing lead hazards in housing; 2) the effectiveness of education in preventing BLL elevations or in reducing already elevated BLLs; and 3) the effectiveness of chelation therapy in preventing or reducing the adverse neurobehavioral outcomes associated with increased BLLs. In particular, the effectiveness and cost-effectiveness of interventions aimed at children with relatively modest elevations in BLLs should be evaluated.

Second, *barriers to screening and other lead poisoning prevention activities should be evaluated* and addressed, especially in places with high-prevalences of elevated BLLs.

Third, further work must be done to *better predict places with high and low prevalences of elevated BLLs*. Such information would be of great help in allocating resources and deciding which areas need more intensive lead poisoning prevention efforts.

Fourth, although some work has evaluated the performance of questionnaires and other tools for identifying individual children with elevated BLLs, additional studies should be done to *improve methods of identifying individual children with substantial BLL elevations* (i.e., BLLs of ≥ 20 µg/dL).

Fifth, *improvements in laboratory methods* that would make BLL screening easier, more efficient, more accurate, and less costly are being developed and tested; as they are implemented, their impact on prevention programs and BLL monitoring will need to be considered.

Sixth, *additional information is needed about the contribution of nonpaint sources of lead* to increased BLLs in children. This should include information about lead taken home from workplaces of adults.

Finally, **more information on the likelihood that children with negative BLL screening tests at ages 1 and 2 will have elevated BLLs later in life** would help to refine the screening schedule.

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Glossary

Included in this section are two sets of definitions. One set is generally used in public health, child health care, and preventive medicine. The second set is specific to this document.

General	Specific to this Document
Anticipatory guidance is the education provided to parents or caretakers during routine prenatal or pediatric visit to prevent or reduce the risk to their fetuses or children of developing a particular health problem.	***Anticipatory guidance*** is the education provided to parents or caretakers during a routine prenatal or pediatric visit to prevent or reduce the risk to their fetuses or children of developing lead poisoning. In general, anticipatory guidance for lead should include information about the dangers of deteriorating lead-based paint in homes and of improper renovation or remodeling that disturbs lead-based paint.
Assessment is the process, usually carried out or coordinated by a public health agency, of determining the nature and extent of hazards and health problems within a jurisdiction.	
	A ***blood lead level (BLL)*** is the concentration of lead in a sample of blood. This concentration is usually expressed in micrograms per deciliter (Fg/dL) or millimoles per liter (mmol). One Fg/dL is equal to 0.048 mmol.
	Case management is the formal coordination of the care of a child with a blood lead level that exceeds a specific value—as determined by local or state officials—and the assurance that services needed by that child are provided.
	Clinical management is the care of a lead-poisoned child that is usually performed by a child health-care provider. It includes diagnostic testing, follow-up testing at appropriate intervals, clinical evaluation, and if necessary, additional follow-up services and chelation therapy.
A ***diagnostic test*** is a laboratory test used to determine whether a person has a particular health problem.	A ***diagnostic test*** is the first venous blood lead test performed within 6 months on a child who has previously had an elevated blood lead level on a screening test.

General	Specific to this Document
A ***follow-up test*** is a laboratory test for the purpose of monitoring the care of a person with a particular health problem.	A ***follow-up test*** refers to a blood lead test used to monitor the status of a child with a previously elevated diagnostic test for lead.
A ***jurisdiction*** is the geographic area over which a state or local government has political authority. Counties and incorporated places, such as cities, boroughs, towns, and villages, are examples of jurisdictions. One jurisdiction may lie partially or totally within another, such as a county within a state.	
	Childhood ***lead poisoning*** consists of the harmful effects of lead on children. A child is "lead poisoned" if he or she has developed one or more of the harmful effects of lead as a result of exposure to lead.
	A ***lead poisoning prevention program*** is an organized set of activities, including primary and secondary prevention activities, to prevent childhood lead poisoning.
	A ***personal-risk questionnaire*** is administered by a child health-care provider to the parents or guardians of a young child to help determine whether a child is at increased risk of having an elevated blood lead level. The personal-risk questionnaire is one component of an individual risk evaluation.
A ***place*** is any geographic area.	
Prevalence is the percentage of a population with a particular characteristic.	***Prevalence*** is the percentage of a population with an elevated blood lead level.
Primary prevention is the prevention of an adverse health effect in an individual or population. One method of accomplishing this is reducing or eliminating a hazard in the environment to which an individual or population is exposed.	

General	Specific to this Document
	A ***recommendation area*** is a place for which a public health agency makes a recommendation on how to screen children living in that place for lead poisoning. A recommendation area can be a country, state, county, city, or other place.
Screening is a method, usually involving a physical examination or a laboratory test, to identify asymptomatic individuals as likely, or unlikely, to have a particular health problem.	***BLL Screening*** for lead poisoning is the routine measurement of BLLs in asymptomatic children.
A ***screening program*** consists of screening for a health problem, a diagnostic evaluation for those with positive screening-test results, and treatment for those in whom the health problem is diagnosed.	A ***screening program*** for lead poisoning is BLL screening, the diagnostic evaluation of children with elevated BLLs, and the provision of educational, environmental, medical, and other services to children found to have elevated BLLs. A screening program is one component of a childhood lead poisoning prevention program.
A ***screening test*** is a laboratory test to identify asymptomatic individuals as likely or unlikely to have a particular health problem.	A ***screening test*** for lead poisoning is a laboratory test for lead that is performed on the blood of an asymptomatic child to determine whether the child has an elevated BLL.
Secondary prevention is the prevention or slowing of the progression of a health problem in affected individuals that is allowed by early detection of the problem.	***Secondary prevention*** is the identification of children with elevated BLLs and the prevention or reduction of further exposure of those children to lead.
	Targeted screening is the screening of some, but not all, children in a recommendation area for lead poisoning. The selection of children to be screened is based on the presence of a factor that places the children at increased risk of developing lead poisoning.
	Universal screening is the screening of all children at ages 1 and 2 in a recommendation area for lead poisoning.